Standard Work Specifications 2017 – Multifamily 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.

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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 OSHA 1910.134 shall be followed for the implementation of a respiratory protection program	Minimize exposure to airborne contaminants (e.g., insulation materials, mold spores, feces, bacteria, chemicals)		1693
2.0100.1d Electrical safety	An electrical safety assessment will be performed All electric tools will be protected by ground-fault circuit interrupters (GFCI)	Avoid electrical shock and arc flash hazards		1694

	Three-wire type extension cords will be used with portable electric tools Worn or frayed electrical cords will not be used Water sources (e.g., condensate pans) and electrical sources will be kept separate Metal ladders will be avoided Special precautions will be taken if knob and tube wiring is present Aluminum foil products will be kept away from live wires For arc flash hazards, NFPA 70E will be consulted			
2.0100.1e Carbon monoxide (CO)	All homes will have a carbon monoxide alarm Ambient CO will be monitored during combustion testing and testing will be discontinued if ambient CO level inside the home or work space exceeds 35 parts per million (ppm)	Protect worker and occupant health		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,	Prevent power tool injuries Prevent buildup of toxic or flammable contaminants		1698

	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			
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 Workers will be trained on how to use PPE Workers will be expected to always use appropriate PPE during work	Prevent worker exposure to toxic substances		1699
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	Prevent heat stroke, heat stress, and cold stress related injuries		1703

	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			
2.0100.1n Fire safety	Ignition sources will be identified and eliminated (e.g., turn off pilot lights and fuel supply) Use of flammable material will be reduced and fire-rated materials will be used	Prevent a fire hazard		1704
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	Protect workers and occupants from potential lead hazards		1706

	The Environmental Protection Agency (EPA) Renovation, Repair, and Painting (RRP) Program Rule (40 CFR Part 745) in pre-1978 homes and proposed changes to this rule (Federal Register/Vol. 75, No. 87/May 6, 2010) will be complied with, to be superseded by any subsequent final rulemaking or any more stringent state or federal standards			
2.0100.1q Site security	Work site will be secured to prevent unauthorized entry Temporarily disconnected eqipment 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

2.0100.2 Work Area Inspection and Stabilization

Topic: Safe Work Practices

Subtopic: Safe Work Practices

Desired Outcome: Provide a safe and stable work environment that will support and sustain work to be performed

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

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
2.0100.2a Inspect to confirm integrity of existing building assembly	An inspection will be conducted for existing conditions that may hinder successful installation of proposed energy improvement	Ensure the work area and associated building assemblies are suitable for the proposed work		4308
2.0100.2b Identify hazardous construction	The inspection will include determination of the presence of known or presumed hazardous construction materials, including	Ensure known or presumed hazardous materials are treated in a manner consistent with all codes and regulations		4309

materials that may be disturbed or compromised by proposed work	lead paint, asbestos, and in the case of window replacement, caulk, which may contain polychlorinated biphenyls Where proposed work can be performed without disturbing suspect materials or under conditions consistent with applicable codes and regulations, a presumption of the presence of hazardous construction materials may be made without actual testing where such testing is not an integral part of the work to be performed			
2.0100.2c Identify environmental conditions that may create or worsen unsafe or unstable building assembly conditions	The inspection will include determination of the presence of adverse environmental conditions, including excess moisture in contact with building assemblies, mold, wood-decaying fungi, and rodent or insect infestation A visual inspection of exposed electrical wires, junction boxes, and related equipment will be made to identify any unsafe conditions Where insulation materials will be delivered into closed cavities, evaluation of wiring types within such cavities will be conducted to determine if proposed insulation application is compatible with current performance characteristics of wiring (e.g., wiring types that present a fire hazard when in close contact with insulation materials, wiring types subject to corrosion when in contact with certain types of insulation or which may be adversely affected by heat, moisture, or process conditions associated with the installation of certain insulation types)	Ensure adverse environmental conditions do not compromise the stability or longevity of proposed work Ensure the integrity and soundness of building assemblies Preserve the safety and integrity of existing building assemblies and materials after installation of proposed improvements		4310
2.0100.2d Address and correct hazardous or adverse conditions	Where excess moisture conditions are identified where their correction is not included in proposed work, such conditions will be corrected before work begins Where building assemblies or components are found to have been damaged or destroyed, such	Ensure the safety and durability of the associated structures Ensure proposed work will not cause or perpetuate unsafe or unhealthy building conditions		4311

	assemblies will be restored before or during proposed work Where indications of rodent infestation are identified, air sealing materials will incorporate anti-gnawing measure (e.g., copper wool in-fill, metal sheeting) When pests have been identified, follow integrated pest management practices to seal holes with pest proof materials (corrosion proof materials)			

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	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

	Open sumps and intentional slab or vapor barrier penetrations will be sealed or capped to control moisture and radon levels			
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 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	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
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 vermiculite attic insulation is present to avoid drawing asbestos fibers into the living space (i.e., use positively pressurized blower door testing)	Protect workers and occupants from potential asbestos hazards		6914

	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	Workers will wear personal protective equipment (PPE) as needed to protect themselves against exposure to hazards (e.g., pests,	Protect worker from exposure to hazards Protect worker from skin contact with liquid nitrogen		3934

equipment (PPE)	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			
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 Gas lines will be leak free when tested by a standing pressure test that meets the approval of the local code	Install gas lines with no leaks		3940
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 All workers will comply with ANSI/NFPA 70E All OSHA standard practices will be followed	Prevent property damage Ensure worker safety		4320

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

2.0106.2 Potential Asbestos-Containing Materials

Topic: Safe Work Practices

Subtopic: Material Safety

Desired Outcome: Work with property managers to ensure Asbestos Containing Materials (ACMs) are treated properly

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

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
2.0106.2a Determine if testing is necessary	Existing insulation will be visually inspected without disturbing the material and evaluated for suspicion of asbestos-containing materials (ACM) Property manager will be asked about known history of insulation Property manager will be informed of potential for additional testing if history is unknown	Confirm likelihood of ACMs		4321
2.0106.2b If ACM may be present, educate property manager for need of testing	Environmental testing service will be retained and notified of area impacted by proposed work	Confirm presence of ACMs		4322
2.0106.2c Asbestos removal	Property manager will arrange for asbestos removal by an asbestos professional in accordance with federal, state, and local requirements; only a licensed or trained professional may abate, repair, or remove ACM Third-party air monitoring during abatement work will be provided in accordance with federal, state, and local requirements At end of abatement process, documents will be provided to the property manager by the contractor that states ACMs were removed in accordance with all applicable federal, state, and local requirements, and no ACMs are present in the work area	Safely remove asbestos from proposed work area		4323

2.0203.3 Combustion Air—Boilers

Topic: Combustion Safety

Subtopic: Vented Gas Appliances

Desired Outcome: Amount and quality of combustion air allows for safe and efficient operation of equipment

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
2.0203.3a Combustion air	Combustion air shall be calculated and provided in conformance with the applicable code adopted by the jurisdiction and manufacturer requirements In instances where conflicts occur between the code and the manufacturer's installation instructions, the more restrictive provisions shall apply (i.e., more air rather than less) In absence of a local code, combustion air shall be calculated and provided in conformance with any of the following: NFPA 54, IFGC, or NFPA 31. Exception: Existing appliances that have passed combustion safety testing using the procedures of BPI 1200 are deemed to have sufficient combustion air.	Meet burner combustion air requirements		4324
2.0203.3b Education	Property manager/occupant will be educated on proper operation of combustion air systems	Ensure occupant safety Ensure optimal operation of equipment		4325

2.0204.2 Isolating Combustion Appliance Rooms (e.g., Boiler Room, Furnace Room, and Generator Room)

Topic: Combustion Safety

Subtopic: Isolation

Desired Outcome: Effective *air barrier* between the combustion appliance room and all other spaces of the building

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

TITLE	SPECIFICATION(S)	OBJECTIVE(S)

2.0204.2a Pre-inspection	Hazardous materials stored in mechanical rooms with air handlers or combustion appliances (e.g., boilers, furnaces) will be identified and removed; operators will be educated on the dangers of storing hazardous materials in these areas Repairs necessary to stabilize work areas and protect or preserve integrity of energy improvement will be completed before subject work begins Mechanical room doors in a fire-rated wall will be closed; problems that cause doors to be blocked open will be determined and resolved	Eliminate existing storage hazards and prevent future dangerous storage occurrences Repair or address moisture, pest, and structure-related issues Provide a safe and stable work environment		4326
2.0204.2b Identification of penetrations	Penetrations will be identified using visual inspections, infrared thermography, smoke, and/or pressure tests [ASTM E1186-03 (2009)]	Locate air leakage pathways to repair		4327
2.0204.2c Preparation	Health and safety concerns will be addressed for occupants, workers, and repair materials in accordance with OSHA standards (OSHA 1926, 1910) The area will be prepared and isolated in accordance with health and safety standards for the application and materials (e.g., extreme temperatures, lead, asbestos, carbon monoxide) Work lighting, work platform, and adequate ventilation will be provided	Provide a safe work environment Provide a safe indoor environmental quality (IEQ) work environment Provide effective repair access		4328
2.0204.2d Sealant and materials selection	Sealants and materials will be compatible with their intended surfaces and applied in accordance with manufacturer specifications Selection will be durable, pest resistant, and have a weather-appropriate seal Indoor sealants will be low VOC products that meet independent testing and verification protocols, such as Green Seal GS-36, "GREENGUARD Children and Schools," or comparable certifications Fire-rated assemblies will be sealed by qualified workers, using materials and sealants permitted by the	Ensure sealants and materials meet or exceed the performance characteristics required of the assembly (e.g., fire rating) Prevent intrusion of moisture and pests into the sealed assembly Prevent exposing workers or occupants to excessive VOC levels Provide a durable and effective isolation of the identified compartmentalized space		4329

	authority having jurisdiction, and in accordance with adopted building codes Mechanical and boiler room enclosures may need to be fire-rated assemblies Materials will be rated for application in approved details; for example, the annular space around a pipe penetration through a fire-rated wall can usually be sealed using mineral wool fire safing sealed with a coating of flexible fire dam material Sealants and materials will be continuous and meet fire resistance rated assembly specifications			
2.0204.2e Verification	Repairs will be verified using visual inspections, infrared thermography, smoke, and/or pressure tests [ASTM E1186-03 (2009)]	Ensure quality and effectiveness of air sealing		4330

2.0205.1 Gas and Oil-Fired Equipment

Topic: Combustion Safety

Subtopic: Gas and Oil-Fired Equipment

Desired Outcome: Combustion products are properly vented to the outdoors

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
2.0205.1a Combustion air	Combustion air shall be calculated and provided in conformance with the applicable code adopted by the jurisdiction, and manufacturer installation requirements In instances where conflicts occur between the code and the manufacturer's installation instructions, the more restrictive provisions shall apply In absence of a local code, combustion air shall be calculated and provided in conformance with any of the following: NFPA 54, IFGC, or NFPA 31	Do not damage building Protect workers and occupants from injury		4331
2.0205.1b Installation	Venting systems will be installed considering proper material, pitch, common venting, chimney liner, clearance, total equivalent length, and	Exhaust combustion products to the outdoors Protect building from damage		4332

	termination in accordance with the applicable code adopted by the jurisdiction and manufacturer installation requirements In instances where conflicts occur between the code and the manufacturer's installation instructions, the more restrictive provisions shall apply In absence of local code, combustion byproducts shall be removed in accordance with any of the following: NFPA 54, IFGC, or NFPA 31	Protect workers and occupants from injury		
2.0205.1c Orphaned equipment	Existing vent system or chimney will be resized or relined in accordance with the applicable code adopted by the jurisdiction when one or more common vented appliances are removed In absence of local code, combustion byproducts shall be removed in accordance with any of the following: NFPA 54, IFGC, or NFPA 31	Exhaust combustion products to the outdoors Protect building from damage Protect workers and occupants from injury		4333

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

2.0302.1 Locking Refrigerant Caps—Mid and High Rise

Topic: Safety Devices

Subtopic: Cooling Equipment

Desired Outcome: Ensure the safety of worker/occupant/building operations staff/property manager

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
2.0302.1a Installing refrigerant locking caps	Where required by code, locking refrigerant caps will be installed on the refrigerant access ports	Ensure worker and occupant safety		4334

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: attics/roofs	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 Conduct coincident humidity control in the living space (e.g. bath and kitchen fans and dryer exhaust safety outside, crawl space/ basement humidity control addressed)	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. Increase durability of seal Avoid moisture-related damage to the home		6928
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		6929
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		6930
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 EPA) Indoor	Reduce potential for occupant exposure to mold and other moisture-related hazards		6931

	airPLUS Construction Specifications Section 1.1 • Possible mitigation by waterproofing or installing draining plane with construction adhesive			

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-dominated climates seasonally)	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
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

2.0502.1 Radon Testing and Evaluation

Topic: Radon

Subtopic: Testing and Evaluation

Desired Outcome: Work completed without increasing occupant exposure to radon

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
2.0502.1a Radon testing and mitigation	EPA guidelines for radon in current edition of "Healthy Indoor Environment Protocols for Home Energy Retrofits" will be followed Test will be limited to conditioned spaces with slab-on or below grade serving as floor, or floor immediately above basement or crawl space Upper floors in multistory buildings with concrete or concrete masonry unit walls will be tested in accordance with AARST standards	Reduce potential for occupant exposure to radon		4336

2.0702.2 Occupant Education

Topic: Occupant Education and Access

Subtopic: Installed Equipment

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

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
2.0702.2a System operation	Basic operation of the equipment will be explained to the building operations staff (e.g., design conditions, efficiency measures, differences from previous system or situation)	Ensure occupants and building operations staff have a reasonable expectation of the equipment capability		4337
2.0702.2b System controls (e.g., thermostat, humidistat)	Proper operation and programming of system controls to achieve temperature and humidity control will be explained to the occupant and provided in a written format	Ensure occupants and building operations staff can operate system controls		4338
2.0702.2c System disconnects	Indoor and outdoor electrical disconnects and fuel shut offs will be demonstrated to occupant	Ensure occupants and building operations staff can shut off equipment in emergencies		4339

2.0702.2d Combustion air inlets	Location of combustion air inlets will be identified for occupant Importance of not blocking inlets will be explained to occupant	Ensure occupants and building operations staff do not block combustion air inlets		4340
2.0702.2e Blocked 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 Occupant will be educated on the importance of leaving interior doors open as much as possible	Ensure occupants and building operations staff do not prevent the equipment from operating as designed		4341
2.0702.2f Routine maintenance	Proper filter selection and how to change filter will be explained to building operations staff Importance of keeping outdoor unit clear of debris, vegetation, decks, and other blockage will be explained to building operations staff Importance and timing of routine professional maintenance will be explained to building operations staff, e.g. inspect, clean, lubricate, replace consumables (i.e., filters, belts, lights), repair and replace	Ensure equipment operates as designed		4342
2.0702.2g Occupant service requests	Appropriate situations of when the occupant should contact the building operations staff will be explained, including: • Fuel odors • Water draining from secondary drain line • 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 • Outdoor unit never defrosts • Unusual noises • Unusual odors	Occupant will contact building operations staff when system is not operating as designed		4343
2.0702.2h Carbon	Occupant will be informed about CO alarms	Protect occupants from injury		4344

monoxide (CO)				
2.0702.2i Warranty and service	Building operations staff/property manager will be provided with relevant manuals and warranties The labor warranty will be explained, and the building operations staff will be given a phone number to call for warranty service	Building staff are equipped with manuals and warranties for future equipment servicing		4345

2.0702.3 Building Operations Staff Education

Topic: Occupant Education and Access

Subtopic: Installed Equipment

Desired Outcome: Building operations staff understands their role and responsibility in the safe, effective, and efficient operation of the equipment

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
2.0702.3a Systems operation, maintenance, and sustainability	Operation of the equipment maintenance will be explained to the building operations staff (e.g., design conditions, efficiency measures, differences from previous system or situation) Operation and maintenance manual will be provided and updated to building operations staff	Ensure building operations staff has an understanding of the equipment's capability Provide long-term resource for maintenance reference		4354
2.0702.3b System controls (e.g., thermostat, humidistat)	Building operations staff will be educated on the sequence of the building systems and their controls Building operations staff will be provided with training that leads to a building operations certification where a competent authority provides such training	Ensure building operations staff and property manager can operate system controls and recognize maintenance requirements		4355
2.0702.3c System disconnects	Indoor and outdoor electrical disconnections and fuel shut offs will be demonstrated to building operations staff	Ensure building operations staff can shut off equipment in emergencies		4356
2.0702.3d Combustion safety awareness	Location of combustion air inlets and gas vents will be identified for building operations staff Importance of not blocking inlets will be explained to building operations staff Building operations staff will understand that flammable material	Ensure building operations staff understands combustion fuel and the associated safety requirements		4357

	will not be stored in the combustion appliance zone			
2.0702.3e System air flow	Importance of cleaning dust and debris from returns grilles will be explained to building operations staff Proper placement of interior furnishings with respect to registers will be explained to building operations staff Negative consequences of closing registers will be explained to building operations staff Importance of leaving interior doors open as much as possible will be explained to building operations staff	Ensure occupants and building operations staff do not prevent equipment from operating as designed		4358
2.0702.3f Routine maintenance	Proper filter selection (minimum MERV 6 rating) and how to change filter will be explained to building operations staff Importance of keeping outdoor unit clear of debris, vegetation, decks, and other blockages will be explained to building operations staff Importance and timing of routine professional maintenance will be explained to building operations staff, e.g., inspect, clean, lubricate, replace consumables (i.e., belts, filters), repair and replace	Ensure equipment operates as designed		4359
2.0702.3g Occupant service requests	Situations when the occupant should contact the building operations staff will be explained, including: • Fuel odors • Water draining from secondary drain line • Emergency heat indicator always on for a heat pump system • Thermal comfort issues • Unusual noises • Unusual odors Building operations staff will be informed of situations where they must call outside resources: • Flooding • Odors • Electrical issues	Educate building operations staff on the occupant's expectations with comfort, efficiency, and indoor environmental quality Ensure building operations staff does not negatively impact equipment		4360
2.0702.3h Carbon monoxide	Building operations staff will be educated on function, location, operation, and service of detector	Maintain detector in operational condition		4361

(CO) detector				
2.0702.3i Warranty and service	Building operations staff/property manager will be provided with relevant manuals and warranties Labor warranty will be explained and the building operations staff/property manager will be given a phone number to call for warranty service	Building staff have manuals and warranties for future servicing		4362

2.0703.1 Sealing/Isolating Exposed Fibrous Insulation in Areas with Routine Human Activity

Topic: Occupant Education and Access

Subtopic: Insulation

Desired Outcome: Occupants protected from insulation particulate exposure

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
2.0703.1a Fibrous Insulation Isolation	Fibrous insulation materials will be encapsulated on all surfaces facing spaces where there is routine human activity Encapsulation materials will be fire rated, if applicable, to preserve the pre-retrofit fire rating of the building assembly, and/or as required by insulation manufacturer or relevant building code Vapor permeability of encapsulation materials will be consistent with predetermined vapor retarder placement	Protect occupants from insulation exposure Maintain fire rating of assembly Protect building from moisture damage		4363

Section 3: Air Sealing

3.1001.5 Penetrations and Chases

Topic: Attics

Subtopic: Penetrations and Chases

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

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)

3.1001.5a Pre-inspection	Gaps, cracks, and holes in fire separations located within the work area will be visually identified and incorporated into air sealing work scope, including those that span two conditioned or unconditioned spaces Where drawings are available that identify specific fire-resistance ratings (i.e., 1 hour, 2 hour), materials and methods will be employed to preserve or restore such rating Where drawings are unavailable or do not identify specific fire-resistance ratings, the fire-resistance rating of the assembly may be inferred from the current construction (i.e., single 5/8 sheetrock, concrete masonry unity), and materials and methods employed will be consistent with restoring or preserving such inferred fire-resistance rating	Ensure a continuous air and fire barrier will be appropriately located between conditioned and unconditioned space		4364
3.1001.5b Backing and infill	Where gaps, cracks, or holes are larger than 1/4" across and/or where the air sealing materials will be subject to temperature variations in excess of 50° F, the need for backing or infill will be evaluated If used, backing or infill will meet specific characteristics of the fire-resistance-rated assembly, and be compatible with the characteristics of the gap, crack, or hole, including preservation of any expansion/contraction characteristics for assembly (e.g., expansion joints, steam pipes, or dissimilar material interfaces with differing coefficients of expansion) Backing or infill will be selected that maintains sealant placement and durability while allowing for the expected movement from expansion, contraction, load deflection, settling at the location, or if existing water control measures are compromised (e.g., rain screen, drip edge, weep holes, gutter and roof drains, scuppers, or other exterior water management elements)	Minimize gap or hole size to ensure successful use of sealant Ensure closure is permanent and supports appropriate load (e.g., wind, snow, insulation) Ensure sealant does not fall out Ensure integrity of the existing water control system		4365

3.1001.5c Sealant selection	Sealants will be compatible with their intended surfaces and applied in accordance with manufacturer specifications Selection will be durable, pest resistant, and have a weather-appropriate seal Indoor sealants will be low volatile organic compound (VOC) products that meet independent testing and verification protocols, such as Green Seal GS-36, "GREENGUARD Children and Schools," or comparable certifications Fire-resistance-rated assemblies will be provided with sealants permitted by the authority having jurisdiction and adopted building code	Prevent intrusion of moisture and pests into the sealed assembly Prevent exposing workers or occupants to excessive VOC levels Ensure sealant meets or exceeds the performance characteristics of the assembly and is compliant with local fire code requirements		4366
3.1001.5d High temperature application	Only noncombustible sealant will be used in contact with chimneys, vents and flues, or any heat source (e.g., non-IC-rated recessed lights, heat lamps, etc.) Sealant application at factory-built vents, flues, and chimneys shall be listed for use with that vent assembly	Preserve integrity and any applicable warranty associated with factory built vent, flue, or chimney assemblies		4367

3.1001.6 Firewall in Unconditioned Attic

Topic: Attics

Subtopic: Penetrations and Chases

Desired Outcome: Firewall separations in unconditioned attics sealed to prevent air leakage, moisture movement, and spread of fire between the unconditioned attic and conditioned space

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1001.6a Pre-inspection	Conduct pre-inspection in accordance with SWS 2.0100.4 Work Area Inspection and Stabilization Gaps, cracks, and holes in fire separations located within the work area will be visually identified and incorporated into air sealing work scope, including those that span two conditioned or unconditioned spaces. Where drawings are available that identify specific fire-resistance ratings (i.e., 1 hour, 2 hour), materials and	Ensure a continuous air- and fire-resistance barrier will be appropriately located between conditioned and unconditioned space		4368

	methods will be employed to preserve or restore such rating Where drawings are unavailable or do not identify specific fire-resistance ratings, the fire-resistance rating of the assembly may be inferred from the current construction (i.e., single 5/8 sheetrock, concrete masonry unit), and materials and methods employed will be consistent with restoring or preserving such inferred fire-resistance rating Air sealing locations will be identified between the firewall and the attic floor			
3.1001.6b Backing and infill	Where gaps, cracks, or holes are larger than 1/4" across and/or where the air sealing materials will be subject to temperature variations in excess of 50° F, the need for backing or infill will be evaluated If used, backing or infill will meet specific characteristics of the fire-resistance-rated assembly and be compatible with the characteristics of the gap, crack, or hole, including preservation of any expansion/contraction characteristics for assembly (e.g., expansion joints, steam pipes, or dissimilar material interfaces with differing coefficients of expansion) Backing or infill will be selected that maintains sealant placement and durability while allowing for the expected movement from expansion, contraction, load deflection, settling at the location, or if existing water control measures are compromised (e.g., rain screen, drip edge, weep holes, gutter and roof drains, scuppers, or other exterior water management elements)	Minimize gap or hole size to ensure successful use of sealant Ensure closure is permanent and supports appropriate load (e.g., wind, snow, insulation) Ensure sealant does not fall out Ensure integrity of the existing water control system		4369
3.1001.6c Sealant selection	Sealants will be compatible with their intended surfaces and applied in accordance with manufacturer specifications Selection will be durable, pest resistant, and have a weather-appropriate seal Indoor sealants will be low volatile organic compounds (VOC) products	Prevent intrusion of moisture and pests into the sealed assembly Prevent exposing workers or occupants to excessive VOC levels Ensure sealant meets or exceeds the performance characteristics of the assembly and is compliant with local fire code requirements		4370

	that meet independent testing and verification protocols, such as Green Seal GS-36, "GREENGUARD Children and Schools," or comparable certifications Fire-resistance-rated assemblies will be provided with sealants permitted by the authority having jurisdiction and adopted building code			
3.1001.6d Joint seal	Continuous seal will be installed around seams, cracks, joints, edges, penetrations, and connections at: • The intersection between firewall and attic floor • If firewall assembly is not monolithic (e.g., balloon framing, CMU, open chase, attic bypass, or with similar penetration through the attic floor plane), attic floor plane penetrations within the firewall assembly will be accessed through the firewall, fully sealed, and firewall surface restored to prevent current or future breaches of the firewall below the attic floor plane from establishing an air flow path to the attic space	Provide airtight, durable seal that does not move, bend, or sag		4371

3.1001.7 Firewall in Conditioned Attic

Topic: Attics

Subtopic: Penetrations and Chases

Desired Outcome: Firewalls sealed to prevent air leakage, moisture movement, and spread of fire between the conditioned attic and roof assembly

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1001.7a Pre-inspection	Conduct pre-inspection in accordance with SWS 2.0100.4 Work Area Inspection and Stabilization Gaps, cracks, and holes in fire separations located within the work area will be visually identified and incorporated into air sealing work	Repair breaches in the firewall Ensure a continuous air and fire-resistance-rated assembly will be appropriately located between conditioned attic and roof assembly		4372

	scope, including those that span two conditioned or unconditioned spaces Where drawings are available that identify specific fire-resistance ratings (i.e., 1 hour, 2 hour), materials and methods will be employed to preserve or restore such rating Where drawings are unavailable or do not identify specific fire-resistance ratings, the fire-resistance rating of the assembly may be inferred from the current construction (i.e., single 5/8 sheetrock, concrete masonry unit (CMU), and materials and methods employed will be consistent with restoring or preserving such inferred fire resistance rating Air sealing locations will be identified between the firewall and the roof assembly			
3.1001.7b Backing and infill	Where gaps, cracks, or holes are larger than 1/4" across and/or where the air sealing materials will be subject to temperature variations in excess of 50° F, the need for backing or infill will be evaluated If used, backing or infill will meet specific characteristics of the fire-resistance-rated assembly and be compatible with the characteristics of the gap, crack, or hole, including preservation of any expansion/contraction characteristics for assembly (e.g., expansion joints, steam pipes, or dissimilar material interfaces with differing coefficients of expansion) Backing or infill will be selected that maintains sealant placement and durability while allowing for the expected movement from expansion, contraction, load deflection, settling at the location, or if existing water control measures are compromised (e.g., rain screen, drip edge, weep holes, gutter and roof drains, scuppers, or other exterior water management elements)	Minimize gap or hole size to ensure successful use of sealant Ensure closure is permanent and supports appropriate load (e.g., wind, snow, insulation) Ensure sealant does not fall out Ensure integrity of the existing water control system		4373
3.1001.7c Sealant selection	Sealants will be compatible with their intended surfaces and applied in	Prevent intrusion of moisture and pests into the sealed assembly		4374

	accordance with manufacturer specifications Selection will be durable, pest resistant, and have a weather-appropriate seal Indoor sealants will be low volatile organic compound (VOC) products that meet independent testing and verification protocols, such as Green Seal GS-36, "GREENGUARD Children and Schools," or comparable certifications Fire-resistance-rated assemblies will be provided with sealants permitted by the authority having jurisdiction and adopted building code	Prevent exposing workers or occupants to excessive VOC levels Ensure sealant meets or exceeds the performance characteristics of the assembly and is compliant with local fire code requirements		
3.1001.7d Joint seal	Continuous seal will be installed around seams, cracks, joints, edges, penetrations, and connections at: • The intersection between firewall and roof assembly • If firewall assembly is not monolithic (e.g., balloon framing, CMU, open chase, attic bypass, or with similar penetration through the attic floor plane), attic floor plane penetrations within the firewall assembly will be accessed through the firewall, fully sealed, and firewall surface restored to prevent current or future breaches of the firewall below the attic floor plane from establishing an air flow path to the attic space	Provide airtight, durable seal that does not move, bend, or sag		4375

3.1001.8 Preparing for and Installing Insulation Around High-Temperature Devices, Systems, and Components

Topic: Attics

Subtopic: Penetrations and Chases

Desired Outcome: Combustible materials kept away from combustion sources

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		

3.1001.8a Pre-Inspection	Conduct pre-inspection in accordance with SWS 2.0100.4 Work Area Inspection and Stabilization Confirm that flues or other high-temperature elements are functioning as designed and do not present a fire or health and safety risk	Ensure a safe, durable workspace that will sustain improvement		4376
3.1001.8b Verify attic prep	Confirm that only noncombustible sealant has been used in contact with chimneys, vents and flues, or any heat source (e.g., non-IC-rated recessed lights, heat lamps, etc.). Remove any noncompliant materials and replace them with materials consistent with application Sealant application at factory-built vents, flues, and chimneys shall be listed for use with that vent assembly Fire blocking in the space around site-built and factory-built chimneys, as required by either the IBC, IRC, or NFPA, as applicable, will be completed and inspected before erection of any insulation dams	Prevent air leakage Ensure materials coming in contact with high-temperature areas will not present a fire hazard Ensure insulation dams maintain clearance		4377
3.1001.8c Isolate high-temperature elements	A rigid, fixed dam having a height greater than the insulation to be installed will be constructed to ensure a 3" clearance between combustion flue vent and dam	Ensure dam material does not bend, move, or sag Prevent a fire hazard		4378
3.1001.8d Sealant selection	Sealants will be compatible with their intended surfaces and applied in accordance with manufacturer specifications Selection will be durable, pest resistant, and have a weather-appropriate seal Indoor sealants will be low volatile organic compound (VOC) Fire-resistance-rated assemblies will be provided with sealants permitted by the authority having jurisdiction and adopted building code	Prevent intrusion of moisture and pests into the sealed assembly Prevent exposing workers or occupants to excessive VOC levels Ensure sealant meets or exceeds the performance characteristics of the assembly and is compliant with local fire code requirements		4379
3.1001.8e Safety	Insulation will not be allowed between a heat-generating appliance and a dam unless material is rated for contact with heat-generating sources	Prevent a fire hazard		4380
3.1001.8f Building operations	Documentation of material and R-value will be provided to building operations staff	Provide occupant with documentation of installation		4381

staff education				

3.1001.9 Sealing Access Doors and Similar Intentional Penetrations

Topic: Attics

Subtopic: Penetrations and Chases

Desired Outcome: Attic access door properly sealed and insulated

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

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1001.9a Worker safety	All worker safety specifications will be in accordance with SWS 2.0100.3 Worker Safety	Ensure worker safety, especially in regard to fall protection considerations and contaminants found in demolition, such as asbestos, lead, polychlorinated biphenyls, etc.		4382
3.1001.9b Occupant safety	Occupant will be notified of changes or repairs to be made An occupant safety plan will be prepared and implemented	Ensure occupant safety		4383
3.1001.9c Pre-inspection	If attic access is below the air and thermal boundary, then the roof and any exterior roof access locations will be addressed in accordance with SWS 3.1801.2 Sealing and Insulating Exterior Roof Access Panels and Hatches If attic access is part of the air and thermal boundary, it will be airtight and insulated	Ensure correct plan of work is selected to maintain the air and thermal boundary		4384
3.1001.9d Sealant selection	Sealants will be compatible with their intended surfaces and applied in accordance with manufacturer specifications Selection will be durable, pest resistant, and have a weather-appropriate seal Indoor sealants will be low volatile organic compound (VOC) products that meet independent testing and verification protocols, such as Green Seal GS-36, "GREENGUARD Children and Schools," or comparable certifications Fire-resistance-rated assemblies will be provided with sealants permitted	Prevent intrusion of moisture and pests into the sealed assembly Prevent exposing workers or occupants to excessive VOC levels Ensure sealant meets or exceeds the performance characteristics of the assembly and is compliant with local fire code requirements		4385

	by the authority having jurisdiction and adopted building code			
3.1001.9e Sealing	Access hatch frames will be sealed using caulk, gasket, weather strip, or otherwise sealed with an air barrier material, suitable film, or solid material Options will be installed with a latch, lock, or frictionally engaged components of a prefabricated unit above the opening that do not require a latch A rigid dam having a height greater than the insulation to be installed will be constructed to contain insulation when attic access is opened	Prevent air leakage		4386
3.1001.9f Installation	Access hatches will be insulated with noncompressible insulation to the same R-value as adjoining insulated assembly Attic hatch rough opening will be surrounded with a durable, rigid protective baffle that is higher than the level of the surrounding attic floor insulation	Achieve uniform R-value on the attic door or hatch Achieve uniform R-value on the attic floor Prevent loose attic floor insulation from entering the living area		4387
3.1001.9g Attachment	Insulation will be permanently attached and in complete contact with the air barrier	Insulate to prescribed R-value		4388
3.1001.9h Quality assurance	Attic access will be adjusted to properly fit the jamb and allow for ease of operation and security Attic access system will be tested for air leakage in accordance with ASTM E1186	Ensure proper operation of the attic access and hardware Prevent air leakage through assembly		4389
3.1001.9i Durability	Completed measure will have a minimum expected service life of 20 years	Ensure a minimum expected service life		4390
3.1001.9j Building operations staff/occupant education	Purpose of insulation and proper hatch operation will be communicated to building operations staff and occupant	Occupant and staff understand how to use the hatch to ensure integrity of insulated and sealed assembly throughout service life		4391

3.1005.2 Skylights and Shafts

Topic: Attics

Subtopic: Other Ceiling Materials

Desired Outcome: Maintain the integrity of the glazing system as part of a continuous *thermal boundary* between the conditioned space and unconditioned space to prescribed R-values

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

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1005.2a Worker safety	All worker safety specifications will be in accordance with SWS 2.0100.3 Worker Safety	Ensure worker safety, especially in regard to fall protection considerations and contaminants found in demolition, such as asbestos, lead, polychlorinated biphenyls, etc.		4392
3.1005.2b Occupant safety	Occupant will be notified of changes or repairs to be made	Ensure occupant safety		4393
3.1005.2c Pre-inspection	Glazing systems and curbs will be inspected for air and water leakage, integrity, proper operation, and security Repairs will be completed before insulation installation If the items above cannot be repaired, the glazing systems will be recommended for replacement before installing insulation Skylight shaft will be inspected to determine insulation strategy	Determine the scope of glazing system repair Prepare skylight for insulation installation		4394
3.1005.2d Sealant selection	Sealants will be compatible with their intended surfaces and applied in accordance with manufacturer specifications Selection will be durable, pest resistant, and have a weather-appropriate seal Indoor sealants will be low volatile organic compound (VOC) products that meet independent testing and verification protocols, such as Green Seal GS-36, "GREENGUARD Children and Schools," or comparable certifications Fire-resistance-rated assemblies will be provided with sealants permitted by the authority having jurisdiction and adopted building code	Prevent intrusion of moisture and pests into the sealed assembly Prevent exposing workers or occupants to excessive VOC levels Ensure sealant meets or exceeds the performance characteristics of the assembly and is compliant with local fire code requirements		4395
3.1005.2e Sealing	Holes and penetrations will be sealed Bypasses will be blocked and sealed Holes within fire-resistance-rated assemblies will be filled with a material permitted by the authority having jurisdiction and adopted building code	Prevent air leakage Preserve fire-resistant properties of fire-resistance-rated assemblies		4396

3.1005.2f Insulation installation	Insulation will be installed in accordance with manufacturer specifications, and in full contact with all sides of existing cavity without gaps, voids, compressions, misalignments, or wind intrusions Fibrous insulation installed on the well walls will be adequately secured to prevent falling or shifting out of place, and will be installed with a continuous backing on the side exposed to the air Insulation will be installed to prescribed R-value Insulation will be installed to meet the specific characteristics of the assembly	Insulate to prescribed R-value Meet all applicable codes		4397
3.1005.2g Building operations staff education	Documentation of material and R-value will be provided to building operations staff	Provide occupant with documentation of installation		4398

3.1005.3 Air Sealing Complex Ceiling Planes

Topic: Attics

Subtopic: Other Ceiling Materials

Desired Outcome: Configuration of complex ceiling planes will be simplified by spanning interior soffits, chases, direct penetrations, and other cavities to provide a continuously sealed *air barrier* between unconditioned attic and conditioned space

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1005.3a Pre-inspection	Conduct pre-inspection in accordance with SWS 2.0100.4 Work Area Inspection and Stabilization Gaps, cracks, and holes in fire separations located within the work area will be visually identified and incorporated into air sealing work scope, including those that span two conditioned or unconditioned spaces Where drawings are available that identify specific fire-resistance ratings (i.e., 1 hour, 2 hour), materials and methods will be employed to preserve or restore such rating	Ensure durability of repairs		4399

	Where drawings are unavailable or do not identify specific fire-resistance ratings, the fire-resistance rating of the assembly may be inferred from the current construction (i.e., single 5/8 sheetrock, concrete masonry unit), and materials and methods employed will be consistent with restoring or preserving such inferred fire-resistance rating Repairs necessary to stabilize work areas and protect or preserve integrity of energy improvement will be completed before subject work begins			
3.1005.3b Locate air sealing plane	Work area will be cleared of existing insulation to locate and identify the optimal air sealing plane Elevation changes, including interior soffits, chases, direct penetrations, and other changes in elevation, will be identified to determine which will be placed on the conditioned side of the air barrier and which will be sealed at all surfaces Where practical, the total square footage of the air barrier will be minimized by capping or sealing openings in the prime air-barrier plane, rather than on all sides of the elevation change	Minimize gross air barrier (and subsequent thermal barrier) square footage by sealing over elevation changes in unconditioned attic spaces		4400
3.1005.3c Spanning material selection	Materials used to span elevation changes will be rigid and self-supporting over the distance spanned Materials will be consistent with existing or intended fire-resistance assemblies Materials will be compatible with adjacent materials and with any proposed insulation designed to come in contact with it The perimeters of all materials installed to span elevation changes will be sealed on all exposed edges with compatible sealants Seals will be used that prevent visible air movement using chemical smoke at 50 pascals of pressure difference	Prevent air leakage from complex ceiling planes. Provide airtight, durable seal that does not move, bend, or sag and can support the weight of installed insulation		4401
3.1005.3d Support	Support material will be installed for spans wider than 24" except when air-barrier material is rated to span greater	Ensure seal stays in place and does not sag		4402

	distance under load (e.g., wind, insulation)			
3.1005.3e Joint seal	Continuous seal will be installed around seams, cracks, joints, edges, penetrations, and connections Prefabricated units may be used when meeting the desired outcome	Provide airtight, durable seal that does not move, bend, or sag		4403
3.1005.3f Sealant selection	Sealants will be compatible with their intended surfaces and applied in accordance with manufacturer specifications Selection will be durable, pest resistant, and have a weather-appropriate seal Indoor sealants will be low volatile organic compounds (VOC) products that meet independent testing and verification protocols, such as Green Seal GS-36, "GREENGUARD Children and Schools," or comparable certifications Fire-resistance-rated assemblies will be provided with sealants permitted by the authority having jurisdiction and adopted building code	Prevent intrusion of moisture and pests into the sealed assembly Prevent exposing workers or occupants to excessive VOC levels Ensure sealant meets or exceeds the performance characteristics of the assembly and is compliant with local fire code requirements		4404
3.1005.3g Adjacent framing	All remaining gaps will be sealed at the top of the ceiling	Provide airtight framing from one finished side of the ceiling to the other		4405

3.1102.1 Wall Penetration Sealing

Topic: Walls

Subtopic: Multifamily Walls

Desired Outcome: Wall penetrations sealed to prevent air leakage, moisture movement, pest migration, sound and/or odor transmission, and spread of fire through the wall

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1102.1a Pre-inspection	Conduct pre-inspection in accordance with SWS 2.0100.4 Work Area Inspection and Stabilization Gaps, cracks, and holes in fire separations located within the work area will be visually identified and incorporated into air sealing work scope, including those that span two conditioned or unconditioned spaces	Ensure a durable, continuous air barrier and a fire-rated assembly, where appropriate		4406

	Where drawings are available that identify specific fire-resistance ratings (i.e., 1 hour, 2 hour), materials and methods will be employed to preserve or restore such rating Where drawings are unavailable or do not identify specific fire-resistance ratings, the fire-resistance rating of the assembly may be inferred from the current construction (i.e., single 5/8 sheetrock, concrete masonry unit (CMU), and materials and methods employed will be consistent with restoring or preserving such inferred fire resistance rating Penetration locations will be identified to determine hole size and fire rating			
3.1102.1b Backing and infill	Where gaps, cracks, or holes are larger than 1/4" across and/or where the air sealing materials will be subject to temperature variations in excess of 50° F, the need for backing or infill will be evaluated If used, backing or infill will meet specific characteristics of the fire-resistance-rated assembly and be compatible with the characteristics of the gap, crack, or hole, including preservation of any expansion/contraction characteristics for assembly (e.g., expansion joints, steam pipes, or dissimilar material interfaces with differing coefficients of expansion) Backing or infill will be selected that maintains sealant placement and durability while allowing for the expected movement from expansion, contraction, load deflection, settling at the location, or if existing water control measures are compromised (e.g., rain screen, drip edge, weep holes, gutter and roof drains, scuppers, or other exterior water management elements)	Minimize gap or hole size to ensure successful use of sealant Ensure closure is durable, pest resistant, weather appropriate, and supports appropriate load (e.g., wind, snow, insulation) Ensure sealant does not fall out Ensure integrity of the existing water control system		4407
3.1102.1c Sealant selection	Sealants will be compatible with their intended surfaces and applied in accordance with manufacturer specifications	Prevent intrusion of moisture and pests into the sealed assembly Prevent exposing workers or occupants to excessive VOC levels		4408

	Selection will be durable, pest resistant, and have a weather-appropriate seal Indoor sealants will be low volatile organic compound (VOC) products that meet independent testing and verification protocols, such as Green Seal GS-36, "GREENGUARD Children and Schools," or comparable certifications Fire-resistance-rated assemblies will be provided with sealants permitted by the authority having jurisdiction and adopted building code	Ensure sealant meets or exceeds the performance characteristics of the assembly and is compliant with local fire code requirements		
3.1102.1d High-temperature application	Only noncombustible sealant will be used in contact with chimneys, vents and flues, or any heat source (e.g. non-IC-rated recessed lights, heat lamps, etc.)	Provide airtight, durable seal that does not move, bend, sag, or combust Prevent a fire hazard		4409
3.1102.1e Penetration seal	Continuous seal will be installed around seams, cracks, joints, edges, and penetrations When a penetration goes all the way through a wall, both sides will be sealed In a hollow core CMU wall, the penetration at the inner wall surface and the exterior wall surface will be sealed, but not compromise existing water control measures (e.g., rain screen, drip edge, weep holes, gutter, and roof drains)	Provide airtight, durable seal that does not move, bend, or sag Maintain integrity of the existing water control system		4410

3.1201.7 Repair, Maintenance, and Weather Stripping of Windows

Topic: Windows and Doors

Subtopic: Maintenance, Repair, and Sealing

Desired Outcome: Windows are airtight and weathertight

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

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1201.7a Worker safety	All worker safety specifications will be in accordance with SWS 2.0100.3 Worker Safety	Ensure worker safety, especially in regard to fall protection considerations and contaminants found in demolition, such as asbestos, lead, polychlorinated biphenyls, etc.		4411

3.1201.7b Occupant safety	Occupant will be notified of changes or repairs to be made An occupant safety plan will be prepared and implemented Occupant will be shown how to properly operate the window system	Ensure occupant safety		4412
3.1201.7c Pre-inspection	Glazing systems will be inspected for air and water leakage, warping, stability, holes, proper hardware operation, proper operation, and security; if the items above cannot be repaired, the glazing systems will be recommended for replacement	Determine the scope of glazing system repair		4413
3.1201.7d Operable glazing system operation and fit	Operable glazing system will be adjusted or repaired to properly fit the jamb and allow for ease of operation (e.g., hardware adjustment and/or replacement)	Ensure proper operation of the operable glazing system		4414
3.1201.7e Fixed glazing system adjustment and seal	Fixed glazing system will be adjusted or repaired to properly fit the jamb In the event the fixed glazing unit has shifted enough to allow light to leak around the perimeter frame, the glass will be properly repositioned in its frame/pocket After repositioning/adjusting, the glass will be sealed to the frame When sealing exterior frame components, internal water drainage systems within the glazing system will be maintained When sealing exterior frame components, wall system water management components will be maintained (e.g., weep holes)	Ensure proper adjustment of glass (e.g., caulking used to seal a gap can compromise the integrity of the thermal pane seal) Ensure an airtight and weathertight fixed glazing system Ensure a durable and secure glazing system Prevent water intrusion		4415
3.1201.7f Sealant selection	Sealants will be compatible with their intended surfaces and applied in accordance with manufacturer specifications Selection will be durable, pest resistant, and have a weather-appropriate seal Indoor sealants will be low volatile organic compound (VOC) products that meet independent testing and verification protocols, such as Green Seal GS-36, "GREENGUARD Children and Schools," or comparable certifications	Prevent intrusion of moisture and pests into the sealed assembly Prevent exposing workers or occupants to excessive VOC levels Ensure sealant meets or exceeds the performance characteristics of the assembly and is compliant with local fire code requirements		4416

	Fire resistance rated assemblies will be provided with sealants permitted by the authority having jurisdiction and adopted building code			
3.1201.7g Frame sealing	When the glazing system trim/frame leaks at wall, the glazing system trim/frame will be sealed to the exterior and/or interior side of the wall When the glazing system components leak at the frame, areas of leakage will be sealed When the existing window frame has penetrations due to old hardware, the abandoned penetrations will be sealed When sealing exterior frame components, internal water drainage systems within the glazing system will be maintained When sealing exterior frame components, wall system water management components will be maintained (e.g., weep holes)	Ensure the glazing system frame is airtight and watertight Prevent water intrusion		4417
3.1201.7h Weather stripping	All weather stripping will be an effective air barrier Durable weather stripping material will be sized to span irregularities in the glazing system, as well as seasonal variations Where weather stripping fits into an existing track, replacement weather strip will be sized to fit the original track and to span irregularities Weather stripping will be installed and mechanically fastened around all four sides of the glazing system Mechanically installed weather stripping carrier will be sealed to surface Operable glazing systems will be tested for ease of operation and airtightness after weather stripping is installed	Identify appropriate weather stripping materials to make an airtight and watertight seal while maintaining the operation of the glazing system Ensure glazing system is airtight and allows for seasonal variation Ensure operable glazing system operates properly after weather stripping is installed		4418
3.1201.7i Quality assurance	Glazing system will be adjusted to properly fit the jamb and allow for ease of operation and security Glazing system will be tested for air leakage in accordance with ASTM E783-02 or ASTM E1186	Ensure proper operation of the glazing system and hardware Prevent air leakage through assembly Prevent water intrusion		4419

	Water management systems and enclosure drainage planes will be verified as maintained			

3.1201.8 Repair, Maintenance, and Weather Stripping of Doors

Topic: Windows and Doors

Subtopic: Maintenance, Repair, and Sealing

Desired Outcome: Doors operable, airtight, and weathertight

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

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1201.8a Worker safety	All worker safety specifications will be in accordance with SWS 2.0100.3 Worker Safety	Ensure worker safety, especially in regard to fall protection considerations and contaminants found in demolition, such as asbestos, lead, polychlorinated biphenyls, etc.		4420
3.1201.8b Occupant safety	Occupant will be notified of changes or repairs to be made An occupant safety plan will be prepared and implemented Occupant will be notified of how to properly operate the door system	Ensure occupant safety		4421
3.1201.8c Pre-inspection	Door system will be inspected for air and water leakage, warping, stability, holes, proper hardware operation, proper operation, and security; if the items cannot be repaired, the door will be recommended for replacement	Determine the scope of door system repair		4422
3.1201.8d Door operation and fit	Door will be adjusted or repaired to properly fit the jamb and allow for ease of operation (e.g., hardware adjustment and/or replacement, re-plane door)	Ensure proper operation of the door system		4423
3.1201.8e Sealant selection	Sealants will be compatible with their intended surfaces and applied in accordance with manufacturer specifications Selection will be durable, pest resistant, and have a weather-appropriate seal Indoor sealants will be low volatile organic compound (VOC) products that meet independent testing and verification protocols, such as Green Seal GS-36, "GREENGUARD Children and Schools," or comparable certifications	Prevent intrusion of moisture and pests into the sealed assembly Prevent exposing workers or occupants to excessive VOC levels Ensure sealant meets or exceeds the performance characteristics of the assembly and is compliant with local fire code requirements		4424

	Fire-resistance-rated assemblies will be provided with sealants permitted by the authority having jurisdiction and adopted building code			
3.1201.8f Frame sealing	When the door trim/frame leaks at wall, the door trim/frame will be sealed to both the exterior and interior side of the wall Door stop will be sealed to door frame When the existing door frame has penetrations due to old hardware, the abandoned penetrations will be sealed Door rail (bottom) and threshold will be adjusted and sealed to ensure tight but operable fit	Ensure the door trim/frame is airtight and watertight		4425
3.1201.8g Weather stripping	All weather stripping will be an effective air barrier Durable weather stripping material will be sized to span irregularities in the door/frame, as well as seasonal variations For sliders and commercial door systems where weather stripping fits into an existing track, replacement weather strip will be sized to fit the original track and to span irregularities Weather stripping will be installed around all four sides of the door Mechanically installed weather stripping carrier will be sealed to surface Door will be tested for ease of operation and airtightness after weather stripping is installed Where doors are required to have a fire-resistance rating, all weather strips and sealants applied to the door will be compatible with the listing of the door	Identify appropriate weather stripping materials to make an airtight and watertight seal while maintaining the operation of the door Ensure door is airtight to allow for seasonal variation Ensure door operates properly after weather stripping is installed		4426
3.1201.8h Quality assurance	Door will be adjusted to properly fit the jamb, and allow for ease of operation and security Door system will be tested for air leakage in accordance with ASTM E783-02 or ASTM E1186	Ensure proper operation of the door and hardware Prevent air leakage through assembly		4427

3.1203.4 Window Replacement

Topic: Windows and Doors

Subtopic: Replacement

Desired Outcome: Maintain a continuous air and thermal barrier, and high efficiency window performance

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

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1203.4a Design considerations	Glazing type will be chosen by location in the building, building height, code, and climate Window frame will be insulated and selected with thermal breaks appropriate to climate Window selection will be based on lowest air leakage rating Window selection will be based on National Fenestration Rating Council (NFRC) rating by climate Glazing with lowest feasible U-value will be specified Window glazing solar heat gain coefficient (SHGC) will be selected by building orientation and climate Water management system will be maintained Windows will meet the performance standard AMAA/WDMA/CSA/101/IS2/A440 Historic preservation requirements will be considered	Ensure the most effective and appropriate glazing system is specified		4428
3.1203.4b Pre-Inspection	Conduct pre-inspection in accordance with SWS 2.0100.4 Work Area Inspection and Stabilization	Ensure safety, effectiveness, and durability of improvements		4429
3.1203.4c Worker safety	All worker safety specifications will be in accordance with SWS 2.0100.3 Worker Safety	Ensure worker safety, especially in regard to fall protection considerations and contaminants found in demolition, such as asbestos, lead, polychlorinated biphenyls, etc.		4430
3.1203.4d Occupant safety	Occupant will be notified of changes or repairs to be made An occupant safety plan will be prepared and implemented Occupant will be shown how to properly operate windows and doors Building management and occupants will be notified about the risk of a child falling from operable windows with sills located more than 72"	Ensure occupant safety		4431

	above any surface outside window opening			
3.1203.4e Sealant selection	Sealants will be compatible with their intended surfaces and applied in accordance with manufacturer specifications Selection will be durable, pest resistant, and have a weather-appropriate seal Indoor sealants will be low volatile organic compound (VOC) products that meet independent testing and verification protocols, such as Green Seal GS-36, "GREENGUARD Children and Schools," or comparable certifications Fire-resistance-rated assemblies will be provided with sealants permitted by the authority having jurisdiction and adopted building code	Prevent intrusion of moisture and pests into the sealed assembly Prevent exposing workers or occupants to excessive VOC levels Ensure sealant meets or exceeds the performance characteristics of the assembly and is compliant with local fire code requirements		4432
3.1203.4f Window location, installation, and sealing	Glazing system frame will be aligned with the wall system's air and thermal boundary to create a continuous air and thermal boundary Glazing system will be installed in accordance with manufacturer specifications Rough opening will be prepared and sealed to the wall system's continuous air and thermal boundary with nonexpanding sealants When replacement windows are being installed within an existing window frame where the original sash has been removed, the window frame will be prepared and sealed to the wall system's continuous air and thermal barrier When the existing window frame has internal weight pockets, the hardware will be removed and the pocket will be insulated and sealed Glazing system will be sealed to the airtight rough opening or the airtight existing frame	Maintain a continuous air and thermal boundary throughout the entire wall system		4433
3.1203.4g Quality assurance	A sampling protocol will be used to test glazing system for air leakage in accordance with ASTM E783-02 A sampling protocol will be used to test glazing system for water leakage in accordance with ASTM E1105-00	Ensure airtight and watertight installation		4434

3.1203.5 Exterior Door Replacement

Topic: Windows and Doors

Subtopic: Replacement

Desired Outcome: Exterior door selection and installation provides a high efficiency continuous air and *thermal boundary*

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1203.5a Design considerations	Door/glass will be selected by location in the building, building height, code, and climate Door frame will be insulated and selected with thermal breaks appropriate to climate Door selection will be based on lowest air leakage rating Door selection will be based on National Fenestration Rating Council (NFRC) rating by climate Door and door glazing with lowest feasible U-value will be specified Glazing within door assemblies will comply with CPSC 16 CFR Part 1201 Door glazing solar heat gain coefficient (SHGC) will be selected by building orientation and climate Water management system will be maintained Historic preservation requirements will be considered	Ensure the most effective and appropriate door system is specified		4435
3.1203.5b Worker safety	All worker safety specifications will be in accordance with SWS 2.0100.3 Worker Safety	Ensure worker safety, especially in regard to fall protection considerations and contaminants found in demolition, such as asbestos, lead, polychlorinated biphenyls, etc.		4436
3.1203.5c Occupant safety	Occupant will be notified of changes or repairs to be made An occupant safety plan will be prepared and implemented Occupant will be shown how to properly operate the door system	Ensure occupant safety		4437
3.1203.5d Sealant selection	Sealants will be compatible with their intended surfaces and applied in accordance with manufacturer specifications	Prevent intrusion of moisture and pests into the sealed assembly Prevent exposing workers or occupants to excessive VOC levels		4438

	Selection will be durable, pest resistant, and have a weather-appropriate seal Indoor sealants will be low volatile organic compound (VOC) products that meet independent testing and verification protocols, such as Green Seal GS-36, "GREENGUARD Children and Schools," or comparable certifications Fire-resistance-rated assemblies will be provided with sealants permitted by the authority having jurisdiction and adopted building code	Ensure sealant meets or exceeds the performance characteristics of the assembly and is compliant with local fire code requirements		
3.1203.5e Door location, installation and sealing	Door frame will be aligned with the wall system's air and thermal boundary to create a continuous air and thermal boundary Door system will be installed in accordance with manufacturer specifications Rough opening will be prepared and sealed to the wall system's continuous air and thermal boundary Door frame will be sealed and flashed to the airtight and watertight rough opening When a replacement door is being installed within an existing frame, the original frame will be prepared and sealed to the wall system's continuous air and thermal boundary, and the door will be weather stripped on all four sides When the existing door frame has penetrations due to old hardware, the abandoned penetrations will be sealed Door rail (bottom) and threshold will be adjusted to ensure tight but operable fit	Maintain a continuous air and thermal boundary throughout the entire wall system		4439
3.1203.5f Quality assurance	Door will be adjusted to properly fit the jamb and allow for ease of operation and security A sampling protocol will be used to test door system for air leakage in accordance with ASTM E783-02 or ASTM E1186 A sampling protocol will be used to test door system for water leakage in accordance with ASTM E1105-00	Ensure proper operation of the door and hardware Ensure airtight and watertight installation		4440

3.1403.1 Air Seal Concrete Floor Slab Foundation: Raised, On Grade, and Below-Grade

Topic: Basements and Crawl Spaces

Subtopic: Slab Foundations

Desired Outcome: Effective *air barrier* between the conditioned space and the ground

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1403.1a Pre-inspection	Conduct pre-inspection in accordance with SWS 2.0100.4 Work Area Inspection and Stabilization Where applicable (generally above-grade concrete slabs between conditioned and unconditioned spaces), gaps, cracks, and holes in fire separations located within the work area will be visually identified and incorporated into air sealing work scope, including those that span two conditioned or unconditioned spaces Where drawings are available that identify specific fire-resistance ratings (i.e., 1 hour, 2 hour), materials and methods will be employed to preserve or restore such rating Where drawings are unavailable or do not identify specific fire-resistance ratings, the fire-resistance rating of the assembly may be inferred from the current construction (i.e., single 5/8 sheetrock, concrete masonry unit), and materials and methods employed will be consistent with restoring or preserving such inferred fire-resistance rating Where applicable, for assembly type and geographic location, test for radon per ANSI-AARST Standard: Protocol for Conducting Radon and Radon Decay Product Measurements in Multifamily Buildings Repairs necessary to stabilize work areas and protect or preserve	Identify and correct conditions which contribute to excessive radon levels Provide a stable slab to ensure durability of the work		4441

	integrity of energy improvement will be completed before subject work begins			
3.1403.1b Identification of penetrations	Penetrations will be identified using visual inspections, smoke, and/or pressure tests [ASTM E1186-03 (2009)]	Locate air leakage pathways to repair		4442
3.1403.1c Preparation	Health and safety concerns for occupants and workers, in relation to repairs and materials, will be addressed in accordance with OSHA standards (OSHA 1926, 1910) The area will be prepared and isolated in accordance with health and safety standards for the application and materials (e.g., extreme temperatures, lead, asbestos, carbon monoxide, moisture) Work lighting, work platform, and adequate ventilation will be provided Access not provided will be created to ensure that repairs can be made (may include localized demolition)	Provide a safe work environment Provide safe indoor environmental quality in the work environment Provide effective repair access		4443
3.1403.1d Sealant and materials selection	Sealants and materials will be compatible with their intended surfaces and applied in accordance with manufacturer specifications Selection will be durable, pest resistant, and have a weather-appropriate seal Indoor sealants will be low volatile organic compound (VOC) products that meet independent testing and verification protocols, such as Green Seal GS-36, "GREENGUARD Children and Schools," or comparable certifications Fire-resistance-rated assemblies will be provided with sealants permitted by the authority having jurisdiction and adopted building code Where penetrations are due to failed or missing expansion joints, sealing materials will be suitable for this application	Prevent intrusion of moisture and pests into the sealed assembly Prevent exposing workers or occupants to excessive VOC levels Ensure sealant meets or exceeds the performance characteristics of the assembly and is compliant with local fire code requirements		4444
3.1403.1e Demolition repair	Access holes will be repaired	Restore surfaces to original condition or better		4445
3.1403.1f Verification	Repairs will be verified by visual inspections, smoke, and/or pressure	Ensure quality and effectiveness of air sealing		4446

	tests consistent with the pre-inspection			

3.1488.3 Covers for Sump Pumps, Drains, Pits, and Other Intentional Slab Penetrations

Topic: Basements and Crawl Spaces

Subtopic: Special Considerations

Desired Outcome: Excess humidity levels, moisture, soil gases, and pests controlled in crawl spaces and basements

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1488.3a Pre-inspection	Conduct pre-inspection in accordance with SWS 2.0100.4 Work Area Inspection and Stabilization Repairs necessary to stabilize treatment areas and protect or preserve integrity of energy improvement will be completed before subject work begins	Repair moisture-, pest-, and structure-related issues		4447
3.1488.3b Installation	All exposed water sources will be capped and operable/able to be opened for maintenance access Caps will be rigid, durable, and suitable for high-moisture exposure Required cap penetrations will be close fitting (do not have to be airtight) and not interfere with drainage of water from above or below the basement floor	Control excess humidity accumulation		4448
3.1488.3c Property manager education	Documentation of material and maintenance requirements will be provided to property manager	Staff can properly maintain the system		4449

3.1501.2 Garages—Sealing Penetrations

Topic: Attached Garages

Subtopic: Garage Openings

Desired Outcome: Openings sealed to prevent air transfer between garages and conditioned spaces

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)	

3.1501.2a Penetrations	All lighting fixtures, wiring, plumbing, venting, ducting, and gas piping penetrations will be sealed	Prevent air leakage and pollutant entry		4450
3.1501.2b Ductwork	All ductwork in attached garage will be sealed in accordance with the duct sealing specifications Where duct system serves any other conditioned or living space, all supply and return openings (including intentional openings designed to heat or cool the garage space) must be disconnected, capped with sheet metal, and completely sealed	Prevent air leakage and pollutant entry, including under conditions when duct fans are not operating		4451
3.1501.2c Cracks	All cracks in walls, ceilings, or floors that separate conditioned space from garage will be sealed, including cracks between mud sill, rim joists, subfloors, and bottom of gypsum board	Prevent air leakage and pollutant entry		4452
3.1501.2d Garage to conditioned space door	Weather stripping, door sweep, or threshold will be installed to stop air leakage in accordance with SWS 3.1201.8 Repair, Maintenance, and Weatherstripping of Doors	Prevent air leakage and pollutant entry		4453
3.1501.2e Glass	Broken glass panes in doors will be replaced, pointed, and glazed, where needed Where glazing is permitted by code, verify that replacement glass meets the intended fire resistance of the assembly penetrated and is safety glazing as mandated by CPSC 16 CFR 1201 Glazing located in wall connecting garage to conditioned space with fire-resistance ratings may be prohibited; confirm that existing glazing application is consistent with all applicable building codes	Prevent air leakage and pollutant entry Preserve design integrity of fire-resistance-rated assemblies between garage and conditioned spaces		4454
3.1501.2f Carbon monoxide (CO) detector	Carbon monoxide alarms or detection systems that comply with applicable codes, laws, and ordinances will be tested and confirmed to be operational upon completion of any enclosure work	Protect occupants from CO exposure from attached garage		4455
3.1501.2g Building operations	Occupant and building operations staff will be educated on need to keep door from garage to conditioned space closed and need to	Reduce risk of CO poisoning inside of garage and adjacent rooms		4456

staff/occupant education	minimize the time any gas engine appliances or grills are operated in the garage, even if the main door is left open			

3.1502.1 Garages—Isolating from Living Spaces

Topic: Attached Garages

Subtopic: Isolating From Living Space

Desired Outcome: Effective *air barrier* between the garage and all other spaces of the building prevents carbon monoxide (*CO*) and exhaust fumes from entering the building

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1502.1a Pre-inspection, including combustion safety	Conduct pre-inspection in accordance with SWS 2.0100.4 Work Area Inspection and Stabilization Gaps, cracks, and holes in fire separations located within the work area will be visually identified and incorporated into air sealing work scope, including those that span two conditioned or unconditioned spaces Where drawings are available that identify specific fire-resistance ratings (i.e., 1 hour, 2 hour), materials and methods will be employed to preserve or restore such rating Where drawings are unavailable or do not identify specific fire-resistance ratings, the fire-resistance rating of the assembly may be inferred from the current construction (i.e., single 5/8 sheetrock, concrete masonry unit), and materials and methods employed will be consistent with restoring or preserving such inferred fire-resistance rating All below-grade and enclosed garages will be equipped with operational exhaust systems that depressurize the garage space with reference to the building Pressure differential of all garages (both enclosed and open) to building will be measured	Repair or address moisture, pest, and structure-related issues Repair ventilation-related issues Provide a safe and stable work environment		4457

	Carbon monoxide (CO) levels will be measured in the garage and building under typical operating conditions before work begins Repairs necessary to stabilize work areas and protect or preserve integrity of energy improvement will be completed before subject work begins			
3.1502.1b Identification of penetrations	Penetrations will be identified using one or more of the following: • Visual inspections • Infrared thermography • Air flow detection smoke or visible mist • Induced pressure tests [ASTM E1186-03 (2009)] The following will be included in the investigation: • Penetrations through walls and ceilings that separate garage from occupied space • Doorways between garage and occupied space • Cracks at sill and rim joist between garage and occupied space, basement, or crawl space • Ductwork and heating, ventilation, and air conditioning equipment located in the garage that serves occupied space	Locate air leakage pathways to repair		4458
3.1502.1c Preparation	Health and safety concerns for occupants and workers, in relation to repairs and materials will be addressed in accordance with OSHA standards (OSHA 1926, 1910) CO levels will be monitored in work areas during repair work consistent with relevant OSHA requirements The area will be prepared and isolated in accordance with health and safety standards for the application and materials (e.g., extreme temperatures, lead, asbestos, CO) Work lighting, work platform and adequate ventilation will be provided	Provide a safe work environment Provide safe indoor environmental quality in the work environment Protect workers from CO exposure Provide effective repair access		4459
3.1502.1d Installation,	Sealants and materials will be compatible with their intended	Prevent intrusion of moisture and pests into the sealed assembly		4460

sealant, and materials selection	surfaces and applied in accordance with manufacturer specifications Selection will be durable, pest resistant, and have a weather-appropriate seal Indoor sealants will be low volatile organic compound (VOC) products that meet independent testing and verification protocols, such as Green Seal GS-36, "GREENGUARD Children and Schools," or comparable certifications Fire-resistance-rated assemblies will be provided with sealants permitted by the authority having jurisdiction and adopted building code	Prevent exposing workers or occupants to excessive VOC levels Ensure sealant meets or exceeds the performance characteristics of the assembly and is compliant with local fire code requirements		
3.1502.1e Verification	Pressure differential of garage to building will be measured CO levels in the building will be measured	Ensure quality and effectiveness of air sealing		4461

3.1502.2 Removing Supply and/or Return Registers from Garages

Topic: Attached Garages

Subtopic: Isolating From Living Space

Desired Outcome: Safe removal of supply and/or return registers

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1502.2a Removal of run-outs feeding the register in the garage	Supply and/or return run feeding the register will be truncated as close to the trunk line as possible If directly connected to the plenum, it will be truncated at the plenum If connected to a Y or T branch system, it will be truncated at the Y or T	Minimize the surface area of duct		4462
3.1502.2b 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 If patch is large enough to flex, it shall be cross-braced 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		4463

3.1502.2c Sealing of the patch	All patches will be sealed with mastic meeting UL 181 and in accordance with manufacturer specifications (and mesh tape where gap exceeds 1/4")	Ensure an airtight, durable patch		4464
3.1502.2d Removal of discarded ducts	All abandoned ductwork will be removed from work area	Provide a clean work site		4465
3.1502.2e 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 fire wall codes	Prevent a fire hazard		4466
3.1502.2f External static pressure testing	Units will be tested for external static pressure (ESP) before and after work If there is a significant rise in ESP, air flow testing according to ANSI/ACCA Standard 5 or ANSI/ASHRAE Standard 11 will be required, and airflow will be adjusted to meet design requirements	Ensure correct system performance		4467

3.1601.6 Preparation and Mechanical Fastening—Low Rise

Topic: Ducts

Subtopic: Duct Preparation

Desired Outcome: Ducts and plenums are properly fastened to prevent leakage

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1601.6a Preparation	Surrounding insulation will be cleared to expose the joints being sealed Duct surface that accepts sealant will be cleaned	Gain access Achieve proper adhesion for airtight seal		4468
3.1601.6b Metal to metal	Ducts will be fastened with a minimum of three equally spaced screws or acceptable mechanical connections	Ensure joints are durable		4469
3.1601.6c Flex to metal	Joints will be fastened with tie bands using a tie band tensioning tool or mechanical band, and sealed with approved mastic and UL181B tape	Ensure joints are durable Reduce air leakage		4470
3.1601.6d Duct board to duct board	Joints will be fastened with a clinch stapler, rated tape, and mastic	Ensure joints are durable Reduce air leakage		4471

3.1601.6e Duct board to flexible duct	An appropriate take-off collar in accordance with NAIMA standards will be used and sealed with approved mastic	Ensure joints are durable Reduce air leakage		4472
3.1601.6f Metal plenum to air handler cabinet	Plenum will be fastened with a minimum of three equally spaced screws on each side Canvas connection between plenum and unit will be installed so that it does not reduce the inside dimensions of the duct	Ensure joints are durable Reduce air leakage Optimize airflow		4473
3.1601.6g Duct board plenum to air handler cabinet	Termination bar or metal strip will be fastened with screws Duct board will be installed between the screw and the termination bar	Ensure joints are durable Reduce air leakage		4474
3.1601.6h Terminal boot to wood	Screws or nails will be used to fasten boot to wood Seams and boot to subfloor will be sealed with mastic	Ensure joints are durable Reduce air leakage		4475
3.1601.6i Terminal boot to gypsum	Boot hanger will be fastened to adjacent framing with screws or nails Boot will be connected to boot hanger with screws Integral snap boots will be installed Seams of boot will be sealed with mastic Boot to gypsum will be sealed with caulk in accordance with local code and standards	Ensure joints are durable Reduce air leakage		4476
3.1601.6j Duct board to flex	An appropriate take-off collar in accordance with NAIMA standards will be used	Ensure joints are durable Reduce air leakage		4477
3.1601.6k Replacement of insulation	Insulation will be returned or replaced with equivalent R-value	Maintain insulation value		4478

3.1601.7 Support—Low Rise

Topic: Ducts

Subtopic: Duct Preparation

Desired Outcome: Ducts and plenums are properly supported

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1601.7a Support of duct	Ductwork will be supported in accordance with the applicable code adopted by the jurisdiction	Eliminate falling and sagging		4479

types (applies to all duct types)	Flexible duct board ducts and plenums will be supported by metal strapping rods or other materials in accordance with applicable standards (NAIMA) Support materials will be applied in a way that does not allow the ductwork to sag, crimp the ductwork, or cause the interior dimensions of the ductwork to be less than specified Metal ducts will be supported by metal strapping, rods, or other materials, per applicable standards			

3.1601.8 Preparation and Mechanical Fastening—Mid and High Rise

Topic: Ducts

Subtopic: Duct Preparation

Desired Outcome: Ducts and plenums properly fastened to prevent leakage

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1601.8a Preparation	Surrounding insulation will be cleared to expose the joints being sealed Duct surface that accepts sealant will be cleaned	Gain access Achieve proper adhesion for airtight seal		4480
3.1601.8b Metal to metal	Ducts will be fastened with a minimum of three equally spaced screws or acceptable mechanical connections	Ensure joints are durable Reduce air leakage		4481
3.1601.8c Flex to metal (150)	Joints will be fastened with tie bands using a tie band tensioning tool or mechanical band, and sealed with approved mastic OR UL181B tape. Must have a minimum performance temperature rating of 165° (per UL 181A-type test) and a minimum tensile strength rating of 50 pounds tensioning tool or mechanical band, and sealed with approved mastic and UL181B tape	Ensure joints are durable Reduce air leakage		4482
3.1601.8d Duct board to duct board	In a repair or replacement, joints will be fastened with clinch stapler, rated tape, and mastic	Ensure joints are durable Reduce air leakage		4483
3.1601.8e Duct board	An approved take-off collar in accordance with NAIMA standards	Ensure joints are durable Reduce air leakage		4484

to flexible duct (152)	will be used and sealed with approved mastic			
3.1601.8f Phenolic board to phenolic board	Joints will be a metal connection fastened together in accordance with manufacturer specifications	Ensure joints are durable		4485
3.1601.8g Phenolic board to flexible duct	Metal take-off collar will be used and mastic will be used on the outside in accordance with manufacturer specifications	Ensure joints are durable Reduce air leakage		4486
3.1601.8h Phenolic board to air handler cabinet	Plenum will be fastened with a minimum of three equally spaced screws on each side and sealed with mastic Canvas connection between plenum and unit will be installed so that it does not reduce the inside diameter of the duct	Ensure joints are durable Optimize air flow Reduce air leakage		4487
3.1601.8i Metal plenum to air handler cabinet	Plenum will be fastened with a minimum of three equally spaced screws on each side and sealed with mastic Canvas connection between plenum and unit will be installed so that it does not reduce the inside dimensions of the duct	Ensure joints are durable Optimize air flow Reduce air leakage		4488
3.1601.8j Duct board plenum to air handler cabinet	Termination bar or metal strip will be fastened with screws and sealed with mastic Duct board will be installed between the screw and the termination bar	Ensure joints are durable Reduce air leakage		4489
3.1601.8k Terminal boot to wood	Screws or nails will be used to fasten boot to wood Seams and boot to subfloor will be sealed with mastic	Ensure joints are durable Reduce air leakage		4490
3.1601.8l Terminal boot to gypsum	Boot hanger will be fastened to adjacent framing with screws or nails Boot will be connected to boot hanger with screws Integral snap boots will be installed Seams of the boot will be sealed with mastic Boot to gypsum will be sealed with caulk in accordance with local code and standards	Ensure joints are durable Reduce air leakage		4491
3.1601.8m Replacement of insulation	Insulation will be returned or replaced with current insulation standards	Insulation values will be maintained		4492

3.1601.9 Support—Mid and High Rise

Topic: Ducts

Subtopic: Duct Preparation

Desired Outcome: Ducts and plenums are properly supported

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1601.9a Support of duct types (applies to all duct types)	Ductwork will be supported in accordance with applicable code adopted by the jurisdiction Flexible duct board ducts and plenums will be supported by metal strapping rods or other materials in accordance with applicable standards (NAIMA) Support materials will be applied in a way that does not allow the ductwork to sag, crimp the ductwork, or cause the interior dimensions of the ductwork to be less than specified Metal ducts will be supported by metal strapping, rods, or other materials in accordance with applicable standards	Eliminate falling and sagging		4493

3.1602.14 Heating, Ventilation, and Air Conditioning Supply, and Return Ducts and Plenums

Topic: Ducts

Subtopic: Duct Sealing

Desired Outcome: Connections between the crawl space and living space eliminated to improve indoor air quality (*IAQ*) and efficiency of the distribution system

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1602.14a Supply plenums (includes conditioned crawl spaces)	Crawl spaces that are used as heating and cooling supply plenums will not be allowed	Improve IAQ in the living space Eliminate connection between the crawl space and living space		4494
3.1602.14b Return plenums	Crawl spaces that are used as heating and cooling return plenums will not be allowed	Improve IAQ in the living space Eliminate connection between the crawl space and living space Improve performance efficiency		4495
3.1602.14c Existing	Condition will be corrected to provide supply and/or return	Improve IAQ in the living space		4496

condition where crawl space is used as supply and/or return plenum	plenums isolated from crawl space before work can continue			

3.1602.15 Ventilation Existing Duct Sealing (All Building Types)

Topic: Ducts

Subtopic: Duct Sealing

Desired Outcome: Improved effectiveness and efficiency of ventilation distribution system

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1602.15a Pre-inspection	Specifications will be field verified as appropriate to site conditions by installer (e.g., fire dampers, other obstructions) Access to all elements of distribution system will be identified Access to all dwelling units and elements of distribution system will be ensured by the installer An inspection will be conducted for mold, water leaks, water damage, and breaches in the surfaces of the isolated space before sealing Repairs will be completed before subject work	Prepare for installation		4497
3.1602.15b Health and safety	Health and safety concerns for occupants and workers, in relation to repairs and materials, will be addressed in accordance with OSHA standards (OSHA 1926, 1910) Area will be prepared and isolated in accordance with health and safety standards for the application and materials (e.g., extreme temperatures, lead, asbestos) Work lighting, work platform, and adequate ventilation will be provided	Provide a safe working environment Provide safe indoor environmental quality (IEQ) in the work environment Provide effective repair access		4498

3.1602.15c Identification of leakage locations	Duct leakage sites will be identified using industry approved approaches (e.g., visual inspections, borescopes, remote cameras, infrared thermography, smoke, and/or pressure tests [ASTM E1186-03 {2009}])	Locate air leakage pathways to repair		4499
3.1602.15d Identify and prioritize leakage locations to be sealed	Duct sealing opportunities will be assessed and prioritized by: Type of hole: 1. Catastrophic holes disconnected, missing ducts, or very large holes 2. Roof curb, close to fan, register boots 3. Holes larger than 1/4" 4. Seams and joints (holes less than 1/4") Accessibility: 1. Easy to access 2. Demolition required 3. Access by internally applied sealants	Maximize efficiency of work effort		4500
3.1602.15e Temporary access	When demolition for access is specified, the installer will: • Make the temporary access using appropriate containment and worker protection • Seal ductwork in accordance with manual sealing specifications listed in row 3.1602.15h • Document repairs using photographs, checklist, and testing, as required • Repair the opening to specification	Protect occupants and workers from work-related contaminants Seal ductwork in otherwise inaccessible locations		4501
3.1602.15f Preparation	Ducts and registers will be cleaned before sealing Presence and type of dampers and smoke control devices will be identified and protected from duct-sealing application	Establish preconditions for effective adhesion duct sealing materials Ensure health and safety of occupant		4502
3.1602.15g Material selection	Sealants and materials will be compatible with their intended surfaces and applied in accordance with manufacturer specifications Duct sealants will be UL 181 compliant	Ensure sealants and materials meet or exceed the performance characteristics required of the assembly (e.g., fire rating)		4503

	Sealants and materials will be continuous and meet fire barrier specifications			
3.1602.15h Duct sealing	Manual sealing of all accessible leakage areas will be completed first: • Reconnect disconnected ducts • Repair missing ducts with like materials • For holes greater than 1/4", backer material with mastic or appropriate sealants will be used • For holes smaller than 1/4", mastic or appropriate sealants will be used (Some sealed joints will allow for movement [e.g., steam pipes, deflection joints]) • If specified, internally applied spray or aerosol sealing will only be applied after any manual sealing is complete • Installer will coordinate access to the ventilation ductwork in the affected dwelling units with the building management and specialized subcontractor(s) • Installer will provide logistical support to subcontractor(s) (e.g., remove/replace rooftop fans, mask duct terminations and openings, manually seal ducts, install flow orifices) • Sealants and sprays will be applied in accordance with manufacturer specifications by a qualified contractor These final steps will be performed for all duct-sealing activities:	Provide proper sequencing of duct improvements Minimize inconvenience to occupants Prevent air leakage in ductwork Prevent contamination of ventilation air flow Improve effectiveness and efficiency of ventilation system		4504

	• Ventilation system will be returned to operational conditions • Installer will document sealing was completed with photographs, checklist, and testing, as required • Installer will conduct final inspection and conduct close out meetings with building management			
3.1602.15i Verification	Final visual inspection of duct sealing activities and installer documentation will be completed Continued operation of dampers and smoke control devices will be verified Flows and pressures will be measured and balanced	Ensure the performance of the ventilation system Ensure occupant health and safety		4505
3.1602.15j Combustion appliance zone testing	Pressure effects caused by fans will be assessed and corrected when found outside of combustion safety standards	Ensure safe operation of combustion appliances		4506
3.1602.15k Occupant/property manager education	Occupant/property manager will be educated on how the system works and its purpose Occupant/property manager will be instructed to not alter or make holes in the ventilation duct system	Ensure the durability of the ventilation system		4507

3.1602.16 Forced Air—Air Sealing System—Low Rise

Topic: Ducts

Subtopic: Duct Sealing

Desired Outcome: Ducts and plenums are sealed to prevent leakage

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1602.16a New component to new component sealant selection	Any closure system used will meet or exceed applicable standards	Ensure effectiveness of air sealing system		4508

3.1602.16b New component to existing component	Seams, cracks, joints, holes, and penetrations less than 1/4" will be sealed using fiberglass mesh and mastic Mastic alone will be acceptable for holes less than 1/4" that are more than 10' from air handler Seams, cracks, joints, holes, and penetrations between 1/4" and 3/4" will be sealed in two stages: • They will be backed using temporary tape (e.g., duct tape) as a support prior to sealing • They will be sealed using fiberglass mesh and mastic	Eliminate air leakage into or out of ducts and plenums Ensure adhesion of primary seal (fiberglass mesh and mastic) to the duct Reinforce the seal Support the mastic and fiberglass mesh during curing		4509
3.1602.16c Existing component to existing component	Fiberglass mesh and mastic will overlap temporary tape by at least 1" on all sides Fiberglass mesh and mastic will become the primary seal Seams, cracks, joints, holes, and penetrations larger than 3/4" will be repaired using rigid duct material	Eliminate air leakage into or out of ducts and plenums Ensure adhesion of primary seal (fiberglass mesh and mastic) to the duct Reinforce the seal Support the mastic and fiberglass mesh during curing		4510

3.1602.17 Forced Air—Air Sealing System Components—Low Rise

Topic: Ducts

Subtopic: Duct Sealing

Desired Outcome: Ducts and plenums are sealed to prevent leakage

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1602.17a Duct boot to interior surface	Gaps between boot and gypsum less than a 1/4" will be sealed using mastic Gypsum edge will be wetted before applying mastic	Prevent air leakage		4511
3.1602.17b Wooden plenums and building cavities	Accessible connections and joints will be made airtight using approved material	Ensure ducts and plenums will not leak out of or into return or supply plenums and ducts		4512
3.1602.17c Air handler cabinet	Joints will be closed Cracks and holes not needed for proper function and service of unit will be sealed using removable	Reduce air leakage while maintaining accessibility		4513

	sealant (e.g., UL 181 approved mastic tape)			
3.1602.17d Filter slot	A pre-manufactured or site-manufactured durable and airtight filter slot cover will be installed	Reduce air leakage while maintaining accessibility		4514

3.1602.18 Framed Platform—Low Rise

Topic: Ducts

Subtopic: Duct Sealing

Desired Outcome: The return duct installed prevents air leakage

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1602.18a Preparation	Debris and dirt will be cleaned out of the return platform Ensure the platform will support the weight of the equipment	Allow for the application of rigid materials and sealants		4515
3.1602.18b 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 the hole size to ensure successful use of sealant Ensure the closure is permanent and supports any load (e.g., return air pressure) Ensure the sealant does not fall out		4516
3.1602.18c Sealant selection	Sealants will be compatible with their intended surfaces Sealants will be continuous and meet fire barrier specifications	Select permanent sealant Ensure that sealant meets or exceeds the performance characteristics of the surrounding materials		4517

3.1602.19 Dual Cooling Up Ducts—Low Rise

Topic: Ducts

Subtopic: Duct Sealing

Desired Outcome: Up ducts sealed to prevent pressurization leakage

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1602.19a Backing and infill	Backing or infill will be provided as needed to meet the specific characteristics of the selected material and the characteristics of the up duct opening	Minimize the hole size to ensure successful use of sealant Ensure the closure is permanent and supports any pressure produced by wind or air handler fan		4518

	A material will be rated for use in duct systems The infill will not bend, sag, or move once installed	Ensure the sealant does not fall out		
3.1602.19b Sealant selection	Sealants will be compatible with their intended surfaces Sealants will be continuous and meet class 1 specifications	Select permanent sealant Ensure sealant meets or exceeds the performance characteristics of the surrounding materials		4519

3.1602.20 Proprietary Spray Application

Topic: Ducts

Subtopic: Duct Sealing

Desired Outcome: Ducts and plenums are sealed to prevent leakage

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1602.20a Internal or external application	Installation of sealant will be applied in a way that meets manufacturer specifications, as well as UL 181M, NFPA 90A, and NFPA 90B	Reduce duct leakage		4520
3.1602.20b Installation	If specified, internally applied spray or aerosol sealing will only be applied after any manual sealing of large gaps is complete Installer will coordinate access to the ductwork in the affected dwelling units with the building/property management and specialized subcontractor(s) Installer will provide logistical support to subcontractor(s) (e.g., mask duct terminations and openings, manually seal ducts, install flow orifices) Sealants and sprays will be applied according to manufacturer specifications by a qualified contractor	Eliminate air leakage into or out of ducts and plenums Ensure occupant and worker safety Provide proper sequence of duct improvements Minimize inconvenience to occupants		4521

3.1602.21 Air Sealing System—Mid and High Rise

Topic: Ducts

Subtopic: Duct Sealing

Desired Outcome: Ducts and plenums are sealed to prevent leakage

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1602.21a New component to new component sealant selection	Any closure system used will meet or exceed applicable standards	Ensure effectiveness of air sealing system		4522
3.1602.21b New component to existing component	Seams, cracks, joints, holes, and penetrations less than 1/4" will be sealed using fiberglass mesh and mastic Mastic alone will be acceptable for holes less than 1/4" that are more than 10' from air handler Seams, cracks, joints, holes, and penetrations between 1/4" and 3/4" will be sealed in two stages: • They will be backed using temporary tape (e.g., duct 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 the seal Support the mastic and fiberglass mesh during curing		4523
3.1602.21c Existing component to existing component	Fiberglass mesh and mastic will overlap temporary tape by at least 1" on all sides Fiberglass mesh and mastic will become the primary seal Seams, cracks, joints, holes, and penetrations larger than 3/4" will be repaired using rigid duct material	Eliminate air leakage into or out of ducts and plenums Ensure adhesion of primary seal (fiberglass mesh and mastic) to the duct Reinforce the seal Support the mastic and fiberglass mesh during curing		4524

3.1602.22 Air Sealing System Components—Mid and High Rise

Topic: Ducts

Subtopic: Duct Sealing

Desired Outcome: Ducts and plenums are sealed to prevent leakage

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1602.22a Duct boot to interior surface	Gaps between boot and gypsum less than a 1/4" will be sealed using mastic Gypsum edge will be wetted before applying mastic	Prevent air leakage		4525

3.1602.22b Wooden plenums and building cavities	Accessible connections and joints will be made airtight using approved material	Ensure ducts and plenums will not leak out of or into return or supply plenums and ducts		4526
3.1602.22c Air handler cabinet	Joints will be closed Cracks and holes not needed for proper function and service of unit will be sealed using removable sealant (e.g., UL 181 approved mastic tape)	Reduce air leakage while maintaining accessibility		4527
3.1602.22d Filter slot	A pre-manufactured or site-manufactured durable and airtight filter slot cover will be installed	Reduce air leakage while maintaining accessibility		4528

3.1602.23 Proprietary Spray Application—Mid and High Rise

Topic: Ducts

Subtopic: Duct Sealing

Desired Outcome: Ducts and plenums are sealed to prevent leakage

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1602.23a Internal or external application	Installation of sealant will be applied in a way that meets manufacturer specifications, as well as UL 181M, NFPA 90A, and NFPA 90B	Reduce duct leakage		4529
3.1602.23b Installation	If specified, internally applied spray or aerosol sealing will only be applied after any manual sealing is complete Installer will coordinate access to the ductwork in the affected dwelling units with the building/property management and specialized subcontractors Installer will provide logistical support to subcontractors (e.g., mask duct terminations and openings, manually seal ducts, install flow orifices) Sealants and sprays will be applied in accordance with manufacturer specifications by a qualified contractor	Eliminate air leakage into or out of ducts and plenums Ensure occupant and worker safety Provide proper sequence of duct improvements Minimize inconvenience to occupants		4530

3.1801.1 Above Roof Deck Air Sealing and Insulation

Topic: Roofs

Subtopic: Roof Decks, Panels, and Hatches

Desired Outcome: Continuous air, thermal and moisture boundary at roof

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1801.1a Worker safety	Worker safety specifications will be in accordance with SWS 2.0100.3 Worker Safety	Ensure worker safety, especially in regard to fall protection considerations and contaminants found in demolition, such as asbestos, lead, polychlorinated biphenyls, etc.		4531
3.1801.1b Occupant safety	An occupant safety plan will be prepared, reviewed with and approved by building operators, and implemented throughout production	Ensure occupant safety		4532
3.1801.1c Pre-inspection	Existing roof water management system will be identified Plans will be made for future water management system Existing roof system will be evaluated to determine suitable materials and techniques that will not compromise the integrity of the roofing system and will not adversely impact warranty or serviceability of roofing system after work has been performed Nail base strategy for the perimeter of the roof will be determined to guide how the flashing and/or roof will be anchored at the exterior of the building	Ensure adequate water management system Ensure adequate roof adherence Prevent air infiltration between roof system and the perimeter of the building		4533
3.1801.1d Roof covering removal	Existing roof covering will be removed	Prepare for installation of above roof deck insulation		4534
3.1801.1e Sealing	If the existing roof deck can be used as an air barrier, joints, seams, holes, gaps, and penetrations will be sealed with sealants compatible with existing materials, and as approved by both sealant manufacturer and manufacturer of materials being sealed	Prevent air and water leaks		4535
3.1801.1f Installation	Insulation will be installed in accordance with manufacturer specifications without gaps, voids,	Install insulation that is properly sealed so insulation performs at specified R-value		4536

of insulation	compressions, misalignments, or exposure to wind intrusion or UV Insulation will be installed to prescribed R-value Before rigid insulation installation, a bead of sealant will be laid along the perimeter of the roof deck to prevent air infiltration and again at subsequent layers of insulation board Roof and wall water management systems will be installed or maintained	Ensure adequate water management system		
3.1801.1g Roof covering replacement	New roof covering will be installed in accordance with manufacturer specifications and local building code requirements	Install roof covering correctly Meet local code requirements		4537
3.1801.1h Building operations staff education	Documentation of material and R-value will be provided to building operations staff	Building operators equipped with documentation of installation		4538

3.1801.2 Sealing and Insulating Exterior Roof Access Panels and Hatches

Topic: Roofs

Subtopic: Roof Decks, Panels, and Hatches

Desired Outcome: Roof access is operable, airtight, weathertight, and properly insulated

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1801.2a Worker safety	All worker safety specifications will be in accordance with SWS 2.0100.3 Worker Safety	Ensure worker safety, especially in regard to fall protection considerations and contaminants found in demolition, such as asbestos, lead, polychlorinated biphenyls, etc.		4539
3.1801.2b Occupant safety	Occupant will be notified of changes or repairs to be made An occupant safety plan will be prepared and implemented	Ensure occupant safety		4540
3.1801.2c Pre-inspection	Location of air and thermal boundary will be identified in the attic, and it will be determined if roof access intersects that boundary Roof access will be inspected for air and water leakage, warping, stability, holes, proper operation, and security	Determine the scope of roof access repair Ensure correct plan of work is selected to maintain the air and thermal boundary		4541

	When the roof access cannot be repaired, the roof access will be recommended for replacement The roof access will be watertight If roof access is part of the air and thermal boundary, then it will be airtight and insulated			
3.1801.2d Roof access operation and fit	Roof access will be adjusted or repaired to properly fit the curb/jamb and allow for ease of operation (e.g., hardware adjustment and/or replacement)	Ensure proper operation of the roof access system		4542
3.1801.2e Sealant selection	Sealants will be compatible with their intended surfaces and applied in accordance with manufacturer specifications Selection will be durable, pest resistant, and have a weather-appropriate seal Indoor sealants will be low volatile organic compound (VOC) products that meet independent testing and verification protocols, such as Green Seal GS-36, "GREENGUARD Children and Schools," or comparable certifications Fire-resistance-rated assemblies will be provided with sealants permitted by the authority having jurisdiction and adopted building code	Prevent intrusion of moisture and pests into the sealed assembly Prevent exposing workers or occupants to excessive VOC levels Ensure sealant meets or exceeds the performance characteristics of the assembly and is compliant with local fire code requirements		4543
3.1801.2f Frame/curb sealing	Roof access frame/curb will be sealed to both the exterior and interior side of the roof/wall to prevent water and air intrusion Roof access stop will be sealed to frame/curb When the existing frame/curb has penetrations due to old hardware, the abandoned penetrations will be sealed	Ensure the roof access frame/curb is air and watertight		4544
3.1801.2g Weather stripping	Appropriate weather stripping materials will be used Durable weather stripping material will be sized to span irregularities in the frame/curb, as well as seasonal variations Weather stripping will be installed around all four sides of the roof access	Make an airtight and watertight seal while maintaining the operation of the roof access Ensure hatch and door is airtight to allow for seasonal variation Ensure roof access operates properly after weather stripping is installed		4545

	Mechanically installed weather stripping carrier will be sealed to surface Roof access will be tested for ease of operation and airtightness after weather stripping is installed			
3.1801.2h Insulation	Access hatches will be insulated with noncompressible insulation to an R-value sufficient to prevent condensation on either the conditioned or unconditioned side, based on local climate conditions Hatch curb will be durably insulated where feasible When access hatches are part of a fire-resistance-rated assembly or are used for smoke or heat removal, added materials will not be permitted When new hatch and flashing is installed, exterior insulation will be added to the curb If the rough opening size allows, interior curb insulation will be installed	Achieve uniform R-value on the roof access sufficient to prevent condensation		4546
3.1801.2i Quality assurance	Roof access will be adjusted to properly fit the jamb and allow for ease of operation and security Roof access system will be tested for air leakage in accordance with ASTM E1186 (smoke pencil, theatrical fog, or infrared)	Ensure proper operation of the roof access and hardware Prevent air leakage through assembly		4547

3.1802.1 Roof/Exterior Wall Connection, Including Joints at Roof/Parapet/Wall Connections

Topic: Roofs

Subtopic: Roof/Wall Connections

Desired Outcome: Continuous *air barrier* between roof and exterior walls where connection is within conditioned space

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

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1802.1a Pre-inspection	Conduct pre-inspection in accordance with SWS 2.0100.4 Work Area Inspection and Stabilization Existing water control measures will be identified	Provide a safe and stable work environment Avoid compromising existing water control system		4548

	Air sealing locations will be identified between the roof and the exterior wall	Ensure a continuous air barrier will be appropriately located at the roof/exterior wall junction		
3.1802.1b Backing and infill	Where gaps, cracks, or holes are larger than 1/4" across and/or where the air sealing materials will be subject to temperature variations in excess of 50° F, the need for backing or infill will be evaluated If used, backing or infill will meet specific characteristics of the fire-resistance-rated assembly, and be compatible with the characteristics of the gap, crack, or hole, including preservation of any expansion/contraction characteristics for assembly (e.g., expansion joints, steam pipes, or dissimilar material interfaces with differing coefficients of expansion) Backing or infill will be selected that maintains sealant placement and durability while allowing for the expected movement from expansion, contraction, load deflection, settling at the location, or if existing water control measures are compromised (e.g., rain screen, drip edge, weep holes, gutter and roof drains, scuppers, or other exterior water management elements)	Minimize gap or hole size to ensure successful use of sealant Ensure closure is permanent and supports appropriate load (e.g., wind, snow, insulation) Ensure sealant does not fall out Ensure integrity of the existing water control system		4549
3.1802.1c Sealant selection	Sealants will be compatible with their intended surfaces and applied in accordance with manufacturer specifications Selection will be durable, pest resistant, and have a weather-appropriate seal Indoor sealants will be low volatile organic compound (VOC) products that meet independent testing and verification protocols, such as Green Seal GS-36, "GREENGUARD Children and Schools," or comparable certifications Fire-resistance-rated assemblies will be provided with sealants permitted by the authority having jurisdiction and adopted building code	Prevent intrusion of moisture and pests into the sealed assembly Prevent exposing workers or occupants to excessive VOC levels Ensure sealant meets or exceeds the performance characteristics of the assembly and is compliant with local fire code requirements		4550
3.1802.1d Joint seal	Continuous seal will be installed at roof/exterior wall junctions or	Provide airtight, durable seal that does not move, bend, or sag		4551

	roof/exterior and wall/parapet junctions, including, but not limited to, beams, cracks, joints, edges, penetrations, and connections For metal roof decks, flutes will be accessed to install sealant between top side of roof deck and roof assembly	Ensure hidden flutes are properly sealed		
3.1802.1e Cavity seal	For framed parapets that are open between conditioned and unconditioned space, the parapet/wall cavity will be accessed, and an internal air barrier will be created within the parapet wall cavity at the roof plane For parapet walls constructed with hollow core concrete masonry units, the hollow cores will be accessed at the roof plane, and an internal air barrier will be created within the parapet wall cavity at the roof plane For exterior insulated finishing system (EIFS) parapet, air sealing measures will preserve designed moisture control gaps between EIFS and wall sheathing	Stop air movement within the parapet/wall cavity to create a continuous air barrier at the roof plane Provide airtight, durable seal that does not move, bend, or sag		4552

3.1802.2 Exterior Overhangs Communicating to or Through Pressure Boundary

Topic: Roofs

Subtopic: Roof/Wall Connections

Desired Outcome: Rigid, airtight continuous *air barrier* at overhang/wall interface

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

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1802.2a Worker safety	All worker safety specifications will be in accordance with SWS 2.0100.3 Worker Safety	Ensure worker safety, especially in regard to fall protection considerations and contaminants found in demolition, such as asbestos, lead, polychlorinated biphenyls, etc.		4553
3.1802.2b Occupant safety	Occupant will be notified of changes or repairs to be made An occupant safety plan will be prepared and implemented	Ensure occupant safety		4554
3.1802.2c Pre-inspection	Conduct pre-inspection in accordance with SWS 2.0100.4 Work Area Inspection and Stabilization	Provide a safe and stable work environment		4555

	Gaps, cracks, and holes in fire separations located within the work area will be visually identified and incorporated into air sealing work scope, including those that span two conditioned or unconditioned spaces Where drawings are available that identify specific fire-resistance-ratings (i.e., 1 hour, 2 hour), materials and methods will be employed to preserve or restore such rating Where drawings are unavailable or do not identify specific fire-resistance ratings, the fire-resistance rating of the assembly may be inferred from the current construction (i.e., single 5/8 sheetrock, concrete masonry unit), and materials and methods employed will be consistent with restoring or preserving such inferred fire-resistance rating Identify overhang locations to determine desired location of air barrier, determine hole size, framing, and material requirements (including fire rating)	Ensure a durable, continuous air barrier and a fire assembly, where appropriate		
3.1802.2d Site	Items and property below and adjacent to work area will be removed from the work areas or will be adequately protected	Prevent damage to objects near the work and workers		4556
3.1802.2e Backing and infill	Where gaps, cracks, or holes are larger than 1/4" across and/or where the air sealing materials will be subject to temperature variations in excess of 50° F, the need for backing or infill will be evaluated If used, backing or infill will meet specific characteristics of the fire-resistance-rated assembly, and be compatible with the characteristics of the gap, crack, or hole, including preservation of any expansion/contraction characteristics for assembly (e.g., expansion joints, steam pipes, or dissimilar material interfaces with differing coefficients of expansion) Backing or infill will be selected that maintains sealant placement and durability while allowing for the expected movement from expansion,	Minimize gap or hole size to ensure successful use of sealant Ensure closure is durable, pest resistant, weather appropriate, and supports appropriate load (e.g., wind, snow, insulation) Ensure sealant does not fall out Ensure integrity of the existing water control system		4557

	contraction, load deflection, settling at the location, or if existing water control measures are compromised (e.g., rain screen, drip edge, weep holes, gutter and roof drains, scuppers, or other exterior water management elements)			
3.1802.2f Sealant selection	Sealants will be compatible with their intended surfaces and applied in accordance with manufacturer specifications Selection will be durable, pest resistant, and have a weather-appropriate seal Indoor sealants will be low volatile organic compound (VOC) products that meet independent testing and verification protocols, such as Green Seal GS-36, "GREENGUARD Children and Schools," or comparable certifications Fire-resistance-rated assemblies will be provided with sealants permitted by the authority having jurisdiction and adopted building code	Prevent intrusion of moisture and pests into the sealed assembly Prevent exposing workers or occupants to excessive VOC levels Ensure sealant meets or exceeds the performance characteristics of the assembly and is compliant with local fire code requirements		4558
3.1802.2g Air barrier	At the overhang, a continuous air barrier will be created to align with the wall air barrier The opening will be closed off with a rigid material that meets assembly fire rating The air barrier will be fastened to framing as appropriate Rigid material and all openings will be sealed to form a complete air barrier	Prevent air leakage by creating a durable air barrier continuous with the wall air barrier Ensure material is able to support wind and insulation loads Ensure final gap is sealed with appropriate sealant		4559
3.1802.2h Quality assurance	Overhang will be visually inspected and tested for airtightness in accordance with ASTM E 1186-03 Water management systems will be verified as maintained	Prevent air leakage through assembly Prevent water intrusion		4560
3.1802.2i Ignition barrier/fire proofing	Where rigid foam plastics are used, in no case will the final thickness exceed the manufacturer's tested thickness used to determine the maximum 75 flame spread and 450 smoke-developed index when tested to ASTM E84 or UL 723	Comply with local codes and ordinances		4561

	Foam, where permissible, will be provided with ignition and thermal barriers as required by code Other fire stop materials may be required for fire resistance-rated walls with openings required to be protected			

3.1901.1 General Compartmentalization Techniques

Topic: Compartmentalization

Subtopic: Multifamily Compartmentalization Techniques

Desired Outcome: Effective *air barrier* between identified isolated and other conditioned spaces of the building

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1901.1a Pre-inspection	Conduct pre-inspection in accordance with SWS 2.0100.4 Work Area Inspection and Stabilization Gaps, cracks, and holes in fire separations located within the work area will be visually identified and incorporated into air sealing work scope, including those that span two conditioned or unconditioned spaces Where drawings are available that identify specific fire-resistance ratings (i.e., 1 hour, 2 hour), materials and methods will be employed to preserve or restore such rating Where drawings are unavailable or do not identify specific fire-resistance ratings, the fire-resistance rating of the assembly may be inferred from the current construction (i.e., single 5/8 sheetrock, concrete masonry unit), and materials and methods employed will be consistent with restoring or preserving such inferred fire-resistance rating Repairs necessary to stabilize work areas, and protect or preserve integrity of energy improvement will	Provide a safe and stable work environment Repair or address moisture, structure, and pest-related issues Ensure that fire separations are preserved		4562

	be completed before subject work begins			
3.1901.1b Identification of penetrations	Penetrations will be identified using visual inspections, infrared thermography, smoke, and/or pressure tests (ASTM E1186-03 [2009])	Locate air leakage pathways to repair		4563
3.1901.1c Preparation	Health and safety concerns will be addressed for occupants and workers, in relation to repairs and materials, will be addressed in accordance with OSHA standards (OSHA 1926, 1910) The area will be prepared and isolated in accordance with health and safety standards for the application and materials (e.g., extreme temperatures, lead, asbestos) Work lighting, work platform, and adequate ventilation will be provided	Provide a safe work environment Provide safe indoor environmental quality (IEQ) work in the work environment Provide effective repair access		4564
3.1901.1d Sealant and materials selection	Sealants and materials will be compatible with their intended surfaces and applied in accordance with manufacturer specifications Selection will be durable, pest resistant, and have a weather-appropriate seal Indoor sealants will be low volatile organic compound (VOC) products that meet independent testing and verification protocols, such as Green Seal GS-36, "GREENGUARD Children and Schools," or comparable certifications Fire-resistance-rated assemblies will be provided with sealants permitted by the authority having jurisdiction and adopted building code	Prevent intrusion of moisture and pests into the sealed assembly Prevent exposing workers or occupants to excessive VOC levels Ensure sealant meets or exceeds the performance characteristics of the assembly and is compliant with local fire code requirements		4565
3.1901.1e Verification	Repairs will be verified by visual inspections, infrared thermography, smoke, and/or pressure tests consistent with the pre-inspection	Ensure quality and effectiveness of air sealing		4566

3.1901.2 Performance-Based Air Sealing of Dwelling Units and Corridors

Topic: Compartmentalization

Subtopic: Multifamily Compartmentalization Techniques

For supporting material, see Building America Solution Center.

Desired Outcome: Control of one or more of the following: building air leakage, stack effect, noise transmission, or improved indoor air quality

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1901.2a Pre-inspection	Conduct pre-inspection in accordance with SWS 2.0100.4 Work Area Inspection and Stabilization Gaps, cracks, and holes in fire separations located within the work area will be visually identified and incorporated into air sealing work scope, including those that span two conditioned or unconditioned spaces Where drawings are available that identify specific fire-resistance ratings (i.e., 1 hour, 2 hour), materials and methods will be employed to preserve or restore such rating Where drawings are unavailable or do not identify specific fire-resistance ratings, the fire-resistance rating of the assembly may be inferred from the current construction (i.e., single 5/8 sheetrock, concrete masonry unit), and materials and methods employed will be consistent with restoring or preserving such inferred fire-resistance rating. Work order repairs requiring access to dwelling units will be reviewed with all relevant authorities (e.g., building management, property management) Access to work areas within dwelling units will be obtained Repairs necessary to stabilize work areas and protect or preserve integrity of energy improvement will be completed before subject work begins	Provide a safe and stable work environment Repair or address moisture, pest, and structure-related issues Obtain access to units and work areas within dwelling units		4567
3.1901.2b Work coordination among trades	Work will be coordinated with all other trades performing work in compartmentalized spaces to	Ensure system wide air sealing and pressure boundary benefits will be achieved		4568

	schedule any required system wide test-out verification			
3.1901.2c Preparation	Health and safety concerns for occupants and workers, in relation to repairs and materials, will be addressed in accordance with OSHA standards (OSHA 1926, 1910) The area will be prepared and isolated in accordance with health and safety standards for the application and materials (e.g., extreme temperatures, lead, asbestos) Work lighting, work platform, and adequate ventilation will be provided	Provide a safe work environment Provide a safe indoor environmental quality (IEQ) in the work environment Provide effective repair access		4569
3.1901.2d Identification of penetrations	Penetrations will be identified using visual inspections, infrared thermography, smoke, and/or pressure tests (ASTM E1186-03 [2009]) Note: Work will preserve existing ventilation performance, including apartment door undercuts, where existing central ventilation design incorporates these undercuts as an intentional pathway from hallways to apartments	Establish baseline air leakage Identify air leakage repair locations Monitor repair progress Preserve IEQ for occupants		4570
3.1901.2e Installation, sealant, and materials selection	Sealants and materials will be compatible with their intended surfaces and applied in accordance with manufacturer specifications Selection will be durable, pest resistant, and have a weather-appropriate seal Indoor sealants will be low volatile organic compound (VOC) products that meet independent testing and verification protocols, such as Green Seal GS-36, "GREENGUARD Children and Schools," or comparable certifications Fire-resistance-rated assemblies will be provided with sealants permitted by the authority having jurisdiction and adopted building code	Prevent intrusion of moisture and pests into the sealed assembly Prevent exposing workers or occupants to excessive VOC levels Ensure sealant meets or exceeds the performance characteristics of the assembly and is compliant with local fire code requirements		4571

3.1901.2f Verification	Repairs will be verified by pressure tests consistent with the pre-inspection Any pressure balance test-out verification will be performed after all work from all trades is completed	Ensure quality and effectiveness of air sealing Meet performance specifications		4572
3.1901.2g Property manager/occupant education	Documentation of material and maintenance requirements will be provided to property manager/occupant, as appropriate	Properly maintain the system		4573

3.1901.3 Chase Ways (e.g., Service Spaces Containing Pipes, Wires, Ducts, and/or Structural Components; Includes Dumbwaiters and Trash Chutes)

Topic: Compartmentalization

Subtopic: Multifamily Compartmentalization Techniques

Desired Outcome: Control of one or more of the following: building air leakage, stack effect, noise transmission, or improved indoor air quality

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1901.3a Pre-inspection	Conduct pre-inspection in accordance with SWS 2.0100.4 Work Area Inspection and Stabilization Gaps, cracks, and holes in fire separations located within the work area will be visually identified and incorporated into air sealing work scope, including those that span two conditioned or unconditioned spaces Where drawings are available that identify specific fire-resistance ratings (i.e., 1 hour, 2 hour), materials and methods will be employed to preserve or restore such rating Where drawings are unavailable or do not identify specific fire-resistance ratings, the fire-resistance rating of the assembly may be inferred from the current construction (i.e., single 5/8 sheetrock, concrete masonry unit), and materials and methods employed	Provide a safe and stable work environment Repair moisture and structure-related issues		4574

	will be consistent with restoring or preserving such inferred fire-resistance rating Repairs necessary to stabilize work areas and protect or preserve integrity of energy improvement will be completed before subject work begins			
3.1901.3b Identification of penetrations	Penetrations will be identified using visual inspections, infrared thermography, smoke, and/or pressure tests (ASTM E1186-03 [2009]) Access will be provided to ensure that repairs can be made (may include localized demolition) Attempts will be made to secure existing building drawings and specifications relating to affected areas to aid in diagnostics and minimize temporary demolition Fire-resistant integrity of existing shafts that span multiple fire separations will be maintained during testing and construction periods	Locate air leakage pathways to repair Provide system-wide air flow control benefits Ensure that breeches of fire-separated spaces are not left unattended during the construction cycle		4575
3.1901.3c Preparation	Health and safety concerns for occupants and workers, in relation to repairs and materials, will be addressed in accordance with OSHA standards (OSHA 1926, 1910) The area will be prepared and isolated in accordance with health and safety standards for the application and materials (e.g., extreme temperatures, lead, asbestos) Work lighting, work platform, and adequate ventilation will be provided	Provide a safe work environment Provide safe indoor environmental quality (IEQ) in the work environment Provide effective repair access		4576
3.1901.3d Installation, sealant, and materials selection	Sealants and materials will be compatible with their intended surfaces and applied in accordance with manufacturer specifications Selection will be durable, pest resistant, and have a weather-appropriate seal Indoor sealants will be low volatile organic compound (VOC) products that meet independent testing and verification protocols, such as Green Seal GS-36, "GREENGUARD	Prevent intrusion of moisture and pests into the sealed assembly Prevent exposing workers or occupants to excessive VOC levels Ensure sealant meets or exceeds the performance characteristics of the assembly and is compliant with local fire code requirements		4577

	Children and Schools," or comparable certifications Fire-resistance-rated assemblies will be provided with sealants permitted by the authority having jurisdiction and adopted building code			
3.1901.3e Demolition repair	Access holes will be repaired Both temporary (during construction) and permanent demolition repairs will preserve the fire-resistance ratings of affected assemblies	Restore surfaces to original condition or better		4578
3.1901.3f Verification	Repairs will be verified by visual inspections, infrared thermography, smoke, and/or pressure tests consistent with the pre-inspection	Ensure quality and effectiveness of air sealing		4579

3.1901.4 Enclosed Common Area Stairwells and Elevators (Floor to Floor Access), Including Rooftop Elevator Mechanical Rooms

Topic: Compartmentalization

Subtopic: Multifamily Compartmentalization Techniques

Desired Outcome: Control of one or more of the following: building air leakage, stack effect, noise transmission, or improved indoor air quality

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1901.4a Pre-inspection	Conduct pre-inspection in accordance with SWS 2.0100.4 Work Area Inspection and Stabilization i Gaps, cracks, and holes in fire separations located within the work area will be visually identified and incorporated into air sealing work scope, including those that span two conditioned or unconditioned spaces Where drawings are available that identify specific fire-resistance ratings (i.e., 1 hour, 2 hour), materials and methods will be employed to preserve or restore such rating Where drawings are unavailable or do not identify specific fire-resistance ratings, the fire-resistance rating of the assembly may be	Provide a safe and stable work environment Repair moisture and structure-related issues Ensure effective operation of fire control system Ensure approval to proceed with work scope		4580

	inferred from the current construction (i.e., single 5/8 sheetrock, concrete masonry unit), and materials and methods employed will be consistent with restoring or preserving such inferred fire-resistance rating Existing mechanical fire control system will be operational, including stairwell doors and closers, fire sprinklers and alarms, and automatic smoke vents Pipes carrying water will be protected from freezing (e.g., contained stairwell is less conditioned, where fire suppression water pipes are sometimes located) Work order repairs regarding elevators and fire control systems will be reviewed with all relevant authorities (e.g., elevator and fire control maintenance services) Repairs necessary to work treatment areas and protect or preserve integrity of energy improvement will be completed before subject work begins			
3.1901.4b Work coordination among trades	Work will be coordinated with all other trades performing work in compartmentalized spaces to schedule system wide test-out verification requirements Verification will be performed after all work from all trades is completed	Ensure system wide air sealing and pressure boundary benefits will be achieved		4581
3.1901.4c Identification of penetrations	Penetrations will be identified using visual inspections, infrared thermography, smoke, and/or pressure tests (ASTM E1186-03 [2009]) Worker access will be provided by all relevant authorities to ensure repairs can be made (e.g., elevator shaft, elevator controls). Workers will follow the OSHA lock out standard.	Locate air leakage pathways to repair Provide access for workers Comply with access limitation requirements		4582
3.1901.4d Preparation	Health and safety concerns for occupants and workers, in relation to repairs and materials, will be addressed in accordance with OSHA standards (OSHA 1926, 1910)	Provide a safe work environment Provide safe indoor environmental quality (IEQ) in the work environment Provide effective repair access		4583

	The area will be prepared and isolated in accordance with health and safety standards for the application and materials (e.g., extreme temperatures, lead, asbestos) Work lighting, work platform, and adequate ventilation will be provided			
3.1901.4e Installation, sealant, and materials selection	Sealants and materials will be compatible with their intended surfaces and applied in accordance with manufacturer specifications Selection will be durable, pest resistant, and have a weather-appropriate seal Indoor sealants will be low volatile organic compound (VOC) products that meet independent testing and verification protocols, such as Green Seal GS-36, "GREENGUARD Children and Schools," or comparable certifications Fire-resistance-rated assemblies will be provided with sealants permitted by the authority having jurisdiction and adopted building code	Prevent intrusion of moisture and pests into the sealed assembly Prevent exposing workers or occupants to excessive VOC levels Ensure sealant meets or exceeds the performance characteristics of the assembly and is compliant with local fire code requirements		4584
3.1901.4f Verification	Repairs will be verified by visual inspections, infrared thermography, smoke, and/or pressure tests consistent with the pre-inspection Any pressure balance test-out verification will be performed after all work from all trades is completed	Ensure quality and effectiveness of air sealing		4585
3.1901.4g Verification: stairwell pressure balancing	All doors, hatches, and louvers in stairwells will be tested and adjusted as a system to ensure effective operation and closure Verification will be performed only after all air sealing work is completed (due to potential changes in pressure relationships across the stairwell and adjacent space boundary)	Ensure doors, hatches, and louvers operate as a system		4586
3.1901.4h Property manager education	Documentation of material and maintenance requirements will be provided to property manager	Staff are equipped to properly maintain the system		4587

Section 4: Insulation

4.1001.8 Spray Polyurethane Foam Vented Roof Decks Preparation

Topic: Attics

Subtopic: General Preparation

Desired Outcome: Backstop or substrate provided to prevent spray polyurethane foam (*SPF*) from entering soffit areas while ensuring required attic ventilation is provided

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

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
4.1001.8a Surface preparation	All surfaces where SPF is applied will be clean, dry, and free of contamination and degradation Substrate surfaces will be wiped, blown, or vacuumed to be free of excessive dust and dirt Grease and oil will be removed using appropriate cleaners or solvents Moisture content of all wood substrate materials will be checked to ensure it is below 18%	Ensure proper bonding of SPF to substrate surfaces		4588
4.1001.8b Installation of vent chutes	Vent chutes will be installed between all rafters or trusses to ensure a continuous ventilation path between the eave or soffit area and the ridge or roof vent Dams will be penetrated by vent chutes, as needed	Allow ventilation of underside of roof deck sheathing while creating an unvented, conditioned attic space		4589
4.1001.8c Installation of insulation dams	Attic space ventilation to be retained will be appropriately baffled and protected to allow for maximum application of foam insulation at exterior top plate/vent interface without blocking or compromising ventilation pathway Installation will allow for the highest possible R-value above the top plate of the exterior wall	Ensure insulation R-value is not reduced Minimize waste of SPF Provide a ventilation path from eave or soffit to ridge vent when a vented roof deck is required Ensure continuous insulation and air seal of top plate and roof deck		4590
4.1001.8d Removal of existing insulation and vapor retarder	All existing attic floor insulation and vapor retarder will be removed	Ensure the new conditioned space is coupled with the conditioned space		4591

4.1003.12 Roof Decks (Underside of Deck—Attic Space Ceilings)—Spray Polyurethane Foam Preparation and Application

Topic: Attics

Subtopic: Attic Ceilings

Desired Outcome: Proper preparation and installation of spray polyurethane foam (*SPF*) to create continuous air and *thermal boundary*

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

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
4.1003.12a Worker safety	All worker safety specifications will be in accordance with SWS 2.0100.3 Worker Safety	Ensure worker safety, especially in regard to fall protection considerations and contaminants found in demolition, such as asbestos, lead, polychlorinated biphenyls, etc.		4592
4.1003.12b Occupant safety	An occupant safety plan will be prepared and implemented	Ensure occupant safety		4593
4.1003.12c Pre-inspection	Conduct pre-inspection in accordance with SWS 2.0100.4 Work Area Inspection and Stabilization Gaps, cracks, and holes in fire separations located within the work area will be visually identified and incorporated into air sealing work scope, including those that span two conditioned or unconditioned spaces Where drawings are available that identify specific fire-resistance ratings (i.e., 1 hour, 2 hour), materials and methods will be employed to preserve or restore such rating Where drawings are unavailable or do not identify specific fire-resistance ratings, the fire-resistance rating of the assembly may be inferred from the current construction (i.e., single 5/8 sheetrock, concrete masonry unit), and materials and methods employed will be consistent with restoring or preserving such inferred fire-resistance rating Repairs necessary to stabilize work areas and protect or preserve	Identify and remediate pest, moisture, and air leakage and electrical problems before installing insulation Ensure a durable, continuous air and thermal boundary		4594

	integrity of energy improvement will be completed before subject work begins Insulation will not be installed if moisture-related issues are not resolved			
4.1003.12d Surface preparation	All surfaces where SPF is applied will be clean, dry, and in accordance with manufacturer specifications for ambient and surface temperatures All existing attic floor insulation and vapor retarder will be removed	Ensure proper bonding of SPF to substrate surfaces Ensure the new conditioned space is coupled with the conditioned space		4595
4.1003.12e Installation of insulation dams	Attic space ventilation to be retained will be appropriately baffled and protected to allow for maximum application of foam insulation at exterior top plate/vent interface	Ensure insulation R-value is not reduced Ensure continuous insulation and air seal of top plate and roof deck		4596
4.1003.12f Installation	Insulation will be installed to prescribed R-value in accordance with manufacturer specifications SPF will be applied to desired thickness onto roof sheathing between rafters or trusses, using a pass thickness maximum as indicated by manufacturer specifications When specified, underside of rafters or trusses will be covered with SPF to provide layer of continuous insulation In colder climates (IECC Zones 5-8) SPF will be installed to a thickness of least class II vapor retarder or have at least class II vapor retarder coating or covering in direct contact with the underside of the SPF In no case will the final thickness exceed the manufacturer's tested thickness used to determine the maximum 75 flame spread and 450 smoke-developed index when tested to ASTM E84 or UL 723 Foam will be provided with ignition and thermal boundaries as required by code	Ensure complete and consistent coverage throughout roof plane Eliminate cracks, gaps, and voids Minimize framing cavity air flow Minimize moisture migration and unwanted condensation in insulation (vapor retarders) Ensure alignment of insulation and air barrier		4597
4.1003.12g 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		6778

	• R-value			

4.1003.13 Roof Decks (Underside of Deck—Attic Space Ceilings)—Spray Polyurethane Foam Vented Roof Decks Installation

Topic: Attics

Subtopic: Attic Ceilings

Desired Outcome: Reduced heat transfer and air leakage through roof and closed attic sections, as well as framing cavities inaccessible to other treatments

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
4.1003.13a Installation	Insulation will be installed to prescribed R-value in accordance with manufacturer specifications Spray polyurethane foam (SPF) will be applied to desired thickness onto roof sheathing between rafters or trusses, using pass thickness maximum as indicated by manufacturer When desired, underside of rafters or trusses will be covered with SPF to provide layer of continuous insulation Where rigid foam plastics are used, in no case will the final thickness exceed the manufacturer's tested thickness used to determine the maximum 75 flame spread and 450 smoke-developed index when tested to ASTM E84 or UL 723 Foam will be provided with ignition and thermal boundaries, as required by code Unneeded attic ventilation openings will be covered with a substrate and then covered with SPF In colder climates (IECC Zones 5-8) SPF will be installed to a thickness of least class II vapor retarder or have at least class II vapor retarder coating or covering in direct contact with the underside of the SPF	Ensure complete and consistent coverage throughout roof plane Eliminate cracks, gaps, and voids Minimize framing cavity air flow Minimize moisture migration and unwanted condensation in insulation (vapor retarders) Ensure alignment of insulation and air barrier		4598
4.1003.13b Onsite documentation	A dated receipt signed by the installer will be provided that includes:	Document job completion to contract specifications		4599

	☐ Coverage area ☐ Thickness ☐ R-value	Confirm amount of insulation installed Comply with 16 CFR 460.17		
4.1003.13c Building operations staff education	Documentation of material and R-value will be provided to building operations staff	Provide occupant with documentation of installation		4600

4.1003.14 Accessible Unvented Flat Roof with or without Existing Insulation

Topic: Attics

Subtopic: Attic Ceilings

Desired Outcome: Insulation reduces heat flow through unvented roof

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

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
4.1003.14a Worker safety	All worker safety specifications will be in accordance with SWS 2.0100.3 Worker Safety	Ensure worker safety, especially in regard to fall protection considerations and contaminants found in demolition, such as asbestos, lead, polychlorinated biphenyls, etc.		4601
4.1003.14b Occupant safety	An occupant safety plan will be prepared and implemented	Ensure occupant safety		4602
4.1003.14c Pre-inspection	Conduct pre-inspection in accordance with SWS 2.0100.4 Work Area Inspection and Stabilization Insulation will not be installed if moisture-related issues are not resolved	Ensure a durable, continuous air and thermal boundary		4603
4.1003.14d Preparation	New insulation that is not designed to also serve as an air barrier will not be added until all air sealing has been completed Existing insulation will be inspected to confirm that it is not concealing air barrier weaknesses, and is in full contact and alignment with the air barrier Where the insulation is disturbed or found not to be in contact with the air barrier, it will be reinstalled to be in contact with the air barrier; if it cannot be reinstalled or if its condition compromises its	Minimize potential for warm, moist air to enter the attic and condense on cold surfaces Ensure proper performance of insulation Verify uniformity of insulation material Provide location of electrical junctions for future servicing Prevent an electrical hazard		4604

	effectiveness, the insulation will be removed Insulation will be marked for depth a minimum of every 300 square feet of attic area with measurement beginning at the air barrier All electrical junctions will be flagged to be seen above the level of the insulation Covers will be installed on open electrical junction boxes Insulation dams and enclosures (e.g., can lights, sprinkler systems, access hatch, chimney) will be installed as required Where loose fill or batt insulation is used, it will have a maximum 25 flame spread/50 smoke-developed index when tested to ASTM E84 or UL 723 Where rigid foam plastics are used, in no case will the final thickness exceed the manufacturer's tested thickness used to determine the maximum 75 flame spread and 450 smoke-developed index when tested to ASTM E84 or UL 723 Foam will be provided with ignition and thermal boundaries as required by code			
4.1003.14e Installation	Attic insulation will be installed without gaps, voids, compressions, misalignments, or wind intrusions Roof cavities will be blown with loose-fill insulation without gaps, voids, compressions, misalignments, or wind intrusions Insulation will be installed to prescribed R-value Final R-value will account for the compression of existing insulation	Insulate to prescribed R-value		4605
4.1003.14f Ventilation	Code compliant ventilation will be installed before insulation	Reduce possibility of moisture issues		4606
4.1003.14g 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	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		4607

	□ Number of bags installed in accordance with manufacturer specifications			

4.1005.8 Loose Fill Over Existing Insulation on Accessible Attic Floors

Topic: Attics

Subtopic: Attic Floors

Desired Outcome: Insulation controls heat transfer through ceiling

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
4.1005.8a Preparation	New insulation will not be added until all air sealing has been completed Existing insulation will be inspected to confirm that it is not concealing air barrier weaknesses and is in full contact and alignment with the air barrier Where the insulation is disturbed or found not to be in contact with the air barrier, it will be reinstalled to be in contact with the air barrier; if it cannot be reinstalled or if its condition compromises its effectiveness, the insulation will be removed Insulation will be adequately marked for depth a minimum of every 300 square feet of attic area with measurement beginning at the air barrier All electrical junctions will be flagged to be seen above the level of the insulation Open electrical junction boxes will have covers installed Insulation dams and enclosures will be installed as required Blocking will be installed to maintain existing vented attic functionality	Ensure proper performance of insulation Verify uniformity of insulation material Provide location of electrical junctions for future servicing Prevent an electrical hazard		4608
4.1005.8b Installation	The correct depth and number of bags will be blown in accordance with manufacturer specifications	Insulate to prescribed R-value		4609

	Insulation will be installed to prescribed R-value Final R-value will account for the compression of existing insulation			
4.1005.8c Safety	Insulation will not be allowed on top of non-insulation contact (IC)-rated can light boxes or between a heat-generating appliance and a dam unless material is rated for contact with heat-generating sources All insulation materials used will meet ASTM E84 flame spread/smoke development rating of 25/50	Prevent a fire hazard		4610
4.1005.8d 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		4611

4.1088.7 Insulating Inaccessible Attics

Topic: Attics

Subtopic: Special Considerations

Desired Outcome: Insulation installation does not compromise building durability

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
4.1088.7a Worker safety	All worker safety specifications will be in accordance with SWS 2.0100.3 Worker Safety	Ensure worker safety, especially in regard to fall protection considerations and contaminants found in demolition, such as asbestos, lead, polychlorinated biphenyls, etc.		4612
4.1088.7b Pre-inspection	Attics that cannot be air sealed will not be filled with blown insulation At no time will dense pack insulation products be considered an appropriate air barrier material for an inaccessible attic Where attic spaces are inaccessible for air sealing, top of building thermal boundary may be insulated using methods and techniques outlined in	Avoid catastrophic moisture issues in the attic cavity		4613

	SWS 3.1801.1 Above Roof Deck Air Sealing			

4.1088.8 Installation/Correction of Unconditioned Attic Ventilation

Topic: Attics

Subtopic: Special Considerations

For supporting material, see Building America Solution Center.

Desired Outcome: Properly restored vents minimize moisture and ice dams

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
4.1088.8a Pre-inspection	Conduct pre-inspection in accordance with SWS 2.0100.4 Work Area Inspection and Stabilization	Ensure safety, effectiveness, and durability of improvements		4614
4.1088.8b Air barrier and thermal boundary	Attic ventilation will be recommended or installed only if: • The presence of an effective air barrier and thermal boundary between the attic and the living space is verified • Appropriate attic sealing and proper insulation is specified as part of the work scope • Ignition barrier and thermal boundaries are provided when foam plastic materials are used	Ensure presence of continuous air barrier and thermal boundary		4615
4.1088.8c Vent type	Attic vent types will be consistent with requirements for their specific location (e.g., exterior soffit, gable end, roof) and material and intended use (e.g., metal vent on metal roof) Ventilation opening area and configuration will comply with applicable building code	Ensure vent meets proper performance characteristics for location and roofing type		4616
4.1088.8d Vent location	Placement of attic vents will be considered for proper air flow and prevention of entry of wind-driven rain or snow	Encourage proper air flow Minimize entry of wind-driven rain or snow		4617
4.1088.8e Ventilation baffling	Baffling for attic soffit vents will be installed to: • Ensure proper air flow • Prevent wind washing of insulation • Allow maximum insulation coverage	Ensure vent allows proper air flow without compromising insulation performance		4618

	• Ensure baffle terminates above insulation Minimum clearance between insulation and roof deck will be 1"			
4.1088.8f Ventilation screens	All attic ventilation will have screens with noncorroding wire mesh with openings of 1/8" to prevent pest entry (e.g., birds, bats, bees) Existing vents that are not screened will be covered with noncorroding wire mesh with openings of 1/8"	Prevent pest entry		4619

4.1088.9 Tenting, Air Sealing, and Insulating Wet Sprinkler System Components in Unconditioned Attic Spaces

Topic: Attics

Subtopic: Special Considerations

Desired Outcome: Continuous air and *thermal boundary* that does not compromise the sprinkler system

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
4.1088.9a Worker safety	All worker safety specifications will be in accordance with SWS 2.0100.3 Worker Safety	Ensure worker safety, especially in regard to fall protection considerations and contaminants found in demolition, such as asbestos, lead, polychlorinated biphenyls, etc.		4620
4.1088.9b Occupant safety	An occupant safety plan will be prepared and implemented	Ensure occupant safety		4621
4.1088.9c Pre-inspection	Conduct pre-inspection in accordance with SWS 2.0100.4 Work Area Inspection and Stabilization Gaps, cracks, and holes in fire separations located within the work area will be visually identified and incorporated into air sealing work scope, including those that span two conditioned or unconditioned spaces Where drawings are available that identify specific fire-resistance ratings (i.e., 1 hour, 2 hour), materials and methods will be employed to preserve or restore such rating Where drawings are unavailable or do not identify specific fire-resistance ratings, the fire-resistance	Ensure and preserve the integrity of fire separations Ensure a durable, continuous air and thermal boundary		4622

	rating of the assembly may be inferred from the current construction (i.e., single 5/8 sheetrock, concrete masonry unit), and materials and methods employed will be consistent with restoring or preserving such inferred fire-resistance rating Repairs necessary to stabilize work areas and protect or preserve integrity of energy improvement will be completed before subject work begins Insulation will not be installed if moisture-related issues are not resolved			
4.1088.9d Sealant selection	Sealants will be compatible with their intended surfaces and applied in accordance with manufacturer specifications Selection will be durable, pest resistant, and have a weather-appropriate seal Indoor sealants will be low volatile organic compound (VOC) products that meet independent testing and verification protocols, such as Green Seal GS-36, "GREENGUARD Children and Schools," or comparable certifications Fire-resistance rated assemblies will be provided with sealants permitted by the authority having jurisdiction and adopted building code	Prevent intrusion of moisture and pests into the sealed assembly Prevent exposing workers or occupants to excessive VOC levels Ensure sealant meets or exceeds the performance characteristics of the assembly and is compliant with local fire code requirements		4623
4.1088.9e Installation	When tenting is required, an airtight, rigid, and insulated enclosure will be installed around entire sprinkler system exposed within the attic Enclosure will be sealed to the existing attic air barrier Fire-rated materials will be used when applicable Insulation will be installed on top of enclosure to the same R-value as the rest of the attic or rigid insulated enclosure will have an equivalent R-value as the rest of the attic	Align insulation and air barrier Create insulated enclosure that prevents sprinkler system from freezing		4624

4.1103.4 Dense Packing Blown Insulation

Topic: Walls

Subtopic: Enclosed Walls

Desired Outcome: Maintain a consistent, uniform thermal and weather-resistant boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
4.1103.4a Worker safety	All worker safety specifications will be in accordance with SWS 2.0100 Worker Safety Lead safety procedures in buildings built before 1978 will be followed, unless approved testing method proves absence of lead based paint in surfaces that will be disturbed	Ensure worker safety, especially in regard to fall protection considerations and contaminants found in demolition, such as asbestos, lead, polychlorinated biphenyls, etc.		4625
4.1103.4b Occupant safety	Occupant will be notified of changes or repairs to be made An occupant safety plan will be prepared and implemented	Ensure occupant safety		4626
4.1103.4c Pre-inspection	Conduct pre-inspection in accordance with SWS 2.0100.4 Worker Safety Gaps, cracks, and holes in fire separations located within the work area will be visually identified and incorporated into air sealing work scope, including those that span two conditioned or unconditioned spaces Where drawings are available that identify specific fire-resistance ratings (i.e., 1 hour, 2 hour), materials and methods will be employed to preserve or restore such rating Where drawings are unavailable or do not identify specific fire-resistance ratings, the fire-resistance rating of the assembly may be inferred from the current construction (i.e., single 5/8 sheetrock, concrete masonry unit), and materials and methods employed will be consistent with restoring or preserving such inferred fire-resistance rating Repairs necessary to stabilize work areas and protect or preserve the integrity of energy improvement	Identify and remediate pest, moisture, air leakage, and electrical problems before insulation installation Ensure a durable, continuous thermal boundary Avoid compromising existing water control system		4627

	will be completed before work begins Insulation will not be installed if moisture-related issues are not resolved Existing water control measures will be identified Air sealing locations on the exterior walls will be identified Air sealing will be completed before installing insulation			
4.1103.4d Wall access	When feasible, insulation will be installed into cavities from the exterior side of the wall When feasible, exterior cladding at the insulation access point will be removed before creating an access hole through the sheathing Insulation access point will be created to minimize air barrier and drainage plane disruption Access point will be sealed to be airtight and watertight after insulation installation before reinstalling the exterior cladding Water management system will be repaired to function as originally intended (e.g., lapping new felt paper underneath the upper and over the lower joint of the existing felt paper)	Ensure occupant health and safety Minimize disruption within the units Avoid compromising existing water control system Minimize air and moisture flow through the wall system		4628
4.1103.4e Sealant selection	Sealants will be compatible with their intended surfaces and applied in accordance with manufacturer specifications Selection will be durable, pest resistant, and have a weather-appropriate seal Indoor sealants will be low volatile organic compound (VOC) products that meet independent testing and verification protocols, such as Green Seal GS-36, "GREENGUARD Children and Schools," or comparable certifications Fire-resistance-rated assemblies will be provided with sealants permitted by the authority having jurisdiction and adopted building code	Prevent intrusion of moisture and pests into the sealed assembly Prevent exposing workers or occupants to excessive VOC levels Ensure sealant meets or exceeds the performance characteristics of the assembly and is compliant with local fire code requirements		4629

4.1103.4f Exterior dense pack	Using fill tube, 100% of each cavity will be completely filled to a consistent density: • Cellulose insulation used in an enclosed cavity will be installed at 3.5 pounds per cubic foot or greater density • Blown fiberglass, mineral fiber, rock and slag wool, or spray foam used in an enclosed cavity will be installed in accordance at or above manufacturer recommended density to limit air flow that corresponds to an air permeance value of 3.5 cubic feet per minute/square feet at 50 pascals, as measured using the following applicable methods: ASTM C 522, or ASTM E 283, or ASTM E 2178 • All insulation materials used will meet ASTM E84 flame spread/smoke development rating of 25/50 • The number of bags installed will be confirmed and will match the number required on the coverage chart Insulation will be verified to prevent visible air movement at 50 pascals of pressure difference using chemical smoke or other approved verification method by the authority having jurisdiction	Eliminate voids and settling Minimize framing cavity air flow		4630
4.1103.4g 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		6802

4.1103.5 Exterior Wall Surface Insulation

Topic: Walls

Subtopic: Enclosed Walls

Desired Outcome: Complete and continuous thermal *air barrier* around the exterior of the building to minimize thermal bridging

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

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
4.1103.5a Worker safety	All worker safety specifications will be in accordance with SWS 2.0100.3 Worker Safety	Ensure worker safety, especially in regard to fall protection considerations and contaminants found in demolition, such as asbestos, lead, polychlorinated biphenyls, etc		4631
4.1103.5b Occupant safety	Occupant will be notified of changes or repairs to be made An occupant safety plan will be prepared and implemented	Ensure occupant safety		4632
4.1103.5c Pre-inspection	Conduct pre-inspection in accordance with SWS 2.0100.4 Work Area Inspection and Stabilization Repairs necessary to stabilize work areas and protect or preserve integrity of energy improvement will be completed before subject work begins Insulation will not be installed if moisture-related issues are not resolved Existing water control measures will be identified Air sealing locations will be identified on the exterior walls Air sealing will be completed before installing insulation unless an alternative air barrier system will be applied For structures covered by the International Building Code (IBC), all exterior walls to be insulated will be assessed for provision of a thermal boundary (fire stopping) when foam insulating materials are to be used (IBC 2603.4)	Ensure that improvements will not compromise building system integrity Ensure a durable, continuous air and thermal boundary Avoid compromising water control system Ensure that insulation retrofit complies with applicable code regarding fire separation		4633
4.1103.5d Prepare substrate	Exterior siding will be removed as appropriate Where siding materials contain lead, lead-safe work practices will be used	Maintain a safe work environment for workers and occupants Comply with applicable laws, regulations, and codes with regard to hazardous materials		4634

	Where siding contains asbestos, relevant codes regarding its removal and reinstallation will be determined and followed Insulation will not be installed until mold, water leaks, water damage, and pest issues are resolved Repairs necessary to stabilize work areas and protect or preserve integrity of energy improvement will be completed before subject work begins	Ensure there is a solid substrate to apply air barrier and insulation		
4.1103.5e Sealant selection	Sealants will be compatible with their intended surfaces and applied in accordance with manufacturer specifications Selection will be durable, pest resistant, and have a weather-appropriate seal Indoor sealants will be low volatile organic compound (VOC) products that meet independent testing and verification protocols, such as Green Seal GS-36, "GREENGUARD Children and Schools," or comparable certifications Fire-resistance-rated assemblies will be provided with sealants permitted by the authority having jurisdiction and adopted building code	Prevent intrusion of moisture and pests into the sealed assembly Prevent exposing workers or occupants to excessive VOC levels Ensure sealant meets or exceeds the performance characteristics of the assembly and is compliant with local fire code requirements		4635
4.1103.5f Installation	Insulation will be installed to provide a continuous thermal (insulation) barrier to achieve the specified R-value for the assembly being insulated. Where the insulation material does not provide an air barrier as installed, such air sealing as required to create a continuous air barrier in direct contact with thermal (insulation) barrier will be incorporated into the work scope Water management system will be continuous to protect the building Air and thermal boundaries will be integrated with other building systems	Ensure a durable, continuous air and thermal boundary		4636
4.1103.5g Onsite documentation	A dated receipt signed by the installer will be provided that includes: • Insulation type	Document job completion to contract specifications Confirm amount of insulation installed		6804

	• 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)	Comply with 16 CFR 460.17		

4.1301.10 Above-Grade Exposed Floor, Joisted Assemblies

Topic: Floors

Subtopic: Accessible Floors

Desired Outcome: Maintain a consistent, protected, uniform *thermal boundary* between conditioned and unconditioned space to prescribed R-value

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
4.1301.10a Pre-inspection	Conduct pre-inspection in accordance with SWS 2.0100.4 Work Area Inspection and Stabilization Gaps, cracks, and holes in fire separations located within the work area will be visually identified and incorporated into air sealing work scope, including those that span two conditioned or unconditioned spaces Where drawings are available that identify specific fire-resistance ratings (i.e., 1 hour, 2 hour), materials and methods will be employed to preserve or restore such rating Where drawings are unavailable or do not identify specific fire-resistance ratings, the fire-resistance rating of the assembly may be inferred from the current construction (i.e., single 5/8 sheetrock, concrete masonry unit), and materials and methods employed will be consistent with restoring or preserving such inferred fire-resistance rating Repairs necessary to stabilize work areas and protect or preserve integrity of energy improvement will be	Repair moisture-related issues Provide a safe and stable work environment		4637

	completed before subject work begins			
4.1301.10b Preparation	Health and safety concerns will be addressed for occupants, workers, and repair materials in accordance with OSHA standards (OSHA 1926, 1910) Prepare and isolate the area in accordance with health and safety standards for the application and materials (e.g., extreme temperatures, lead, asbestos, carbon monoxide) Work lighting, work platform, and adequate ventilation will be provided	Provide a safe working environment Provide a safe indoor environmental quality working environment Provide effective repair access		4638
4.1301.10c Subfloor preparation	Sealing between conditioned space and unconditioned space will be completed before insulating	Ensure airtight envelope Prevent leakage		4639
4.1301.10d Installation	Insulation will be installed to at least prescribed R-value Insulation will be installed in contact with subfloor without gaps, voids, compressions, misalignments, or wind intrusions If vapor retarders are used, they will be installed consistent with local climate/code requirements	Prevent potential fire chases Provide effective R-value Prevent excessive vapor migration into the floor assembly and/or conditioned space		4640
4.1301.10e Installation of batts or dense pack	Insulation will completely fill the cavity space within the joists or trusses	Minimize sagging, gaps, and voids		4641
4.1301.10f Installation of rigid insulation	Rigid insulation will be mechanically fastened to the bottom of the subfloor or at the bottom of the joists or trusses If attached at the bottom of the joists or trusses, rigid insulation will be attached at the exterior perimeter/band Insulation will be installed either as in-fill or at the bottom of the joists. Where rigid insulation is installed between joists, the perimeter of each joist bay will be air sealed with appropriate sealants to prevent air bypasses around rigid insulation materials Rigid foam plastics used as insulation will incorporate a thermal and ignition barrier, as required by the building code	Minimize convective loops Prevent freezing of plumbing pipes Ensure air barrier is aligned with the insulation		4642

	A continuous air barrier will be installed below the insulation and to the exterior			
4.130.10g Installation of spray polyurethane foam (SPF)	SPF will be applied to bottom side of subfloor between floor joists and all rim/band joists Spray applied foam products will incorporate a thermal and ignition barrier as required by the building code Insulation will be installed by foam installers	Minimize convective loops		4643
4.1301.10h Installation, if mechanicals in joisted assemblies (applies to all insulation types)	All plumbing or mechanical ductwork will be enclosed within the insulated space and will have sufficient insulation on the exterior side	Prevent freezing of plumbing pipes		4644
4.1301.10i Secure batts	Batts will be secured with physical fasteners	Ensure insulation remains in contact with subfloor		4645
4.1301.10j Rigid protective barrier	A continuous rigid barrier, suitable to withstand weather, moisture, and pest contact, and with a fire-resistance rating equal to the resistance rating of the original floor assembly will be mechanically fastened to underside of floor assembly	Protect insulation		4646
4.1301.10k Property manager 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		4647

4.1301.11 Pier Construction Subfloor Insulation—Batt Installation with Rigid Barrier

Topic: Floors

Subtopic: Accessible Floors

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

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
4.1301.11a Subfloor preparation	Sealing between conditioned space and crawl space will be completed before insulating work begins	Ensure airtight envelope Prevent leakage		4648
4.1301.11b Installation	Insulation will be cut as necessary to fit between the floor joists and installed in contact with subfloor without gaps, voids, compressions, misalignments, or wind intrusions If Kraft-faced batts are used, they will be installed with Kraft facing to subfloor Insulation will be installed to prescribed R-value	Insulate to prescribed R-value		4649
4.1301.11c Secure batts	Batts will be secured with physical fasteners	Ensure insulation remains in contact with subfloor		4650
4.1301.11d Rigid air barrier	A rigid air barrier will be mechanically fastened to underside of floor assembly Seams and penetrations will be sealed Rigid barrier will be resistant to pests At minimum, all gaps larger than 1/4" x 1/4" will be stuffed with copper metal mesh or other rodent-proof material If rodents can easily get their mouth around corners, they will be reinforced with hardware cloth or metal angle (e.g., gypsum board bead)	Protect insulation		4651
4.1301.11e Building operations staff 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		4652

4.1301.12 Pier Construction Subfloor Insulation—Spray Polyurethane Foam Preparation and Installation

Topic: Floors

Subtopic: Accessible Floors

Desired Outcome: Floors over unconditioned spaces (e.g., basements, garages) insulated and sealed

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
4.1301.12a Preparation	All floor areas will be open and accessible for spray polyurethane foam (SPF) application Any openings larger than 1/4" will be covered with appropriate materials Insulation dams or end blockers will be installed where needed All surfaces where SPF is applied will be clean, dry, and free of contamination and degradation Substrate surfaces will be wiped, blown, or vacuumed to be free of excessive dust and dirt Grease and oil will be removed using appropriate cleaners or solvents Moisture content of all wood substrate materials will be checked to ensure it is below 18%	Prepare all substrate surfaces for the application of SPF		4653
4.1301.12b Installation	Insulation will be installed to prescribed R-value in accordance with manufacturer specifications Applicator will be certified by a recognized entity for safe and effective application of spray foam SPF will be applied to specified thickness with a tolerance that establishes a minimum thickness; tolerance standards for the installation will NOT use "average" thickness method Insulation will be installed to design thickness to perimeter of floor deck, including all adjacent rim/band joists Application pass thickness will not exceed manufacturer's maximum pass thickness, including inside corners where deck and joists are located	Insulate and seal floors		4654
4.1301.12c Fire protection	SPF will be separated from the occupied space of the building with a thermal and ignition barrier Thermal and ignition barriers will be applied as required by building code to all exposed foam insulation	Provide necessary fire protection for combustible SPF insulation		4655
4.1301.12d Installation for	SPF insulation will not be applied to existing spray-applied fireproofing	Prevent the compromise of the existing fireproofing		4656

fireproofed assemblies with sprayed-on cellulose insulation				
4.1301.12e 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		6814

4.1301.13 Pier Construction Subfloor Insulation—Loose Fill with Rigid Barrier Topic: Floors

Topic: Floors

Subtopic: Accessible Floors

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

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
4.1301.13a Subfloor preparation	Sealing between conditioned space and crawl space will be completed before insulating	Prevent air leakage		4657
4.1301.13b Rigid air barrier	A rigid air barrier will be mechanically fastened to underside of floor assembly Seams and penetrations will be sealed Rigid barrier will be resistant to pests At minimum, all gaps larger than 1/4" x 1/4" will be stuffed with copper metal mesh or other rodent-proof material If rodents can easily get their mouth around corners, they will be reinforced with hardware cloth or metal angle (e.g., gypsum board bead)	Relocate air barrier		4658
4.1301.13c Installation	Loose-fill insulation will be installed between air barrier and subfloor in accordance with manufacturer specifications to achieve required density, maintain consistent coverage, and achieve specified R-value Insulation will be installed to prescribed R-value	Insulate to prescribed R-value		4659

4.1301.13d Building operations staff 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		4660

4.1301.14 Above-Grade Exposed Floor, Non-Joisted Assemblies (e.g., Pre-Cast Concrete, Poured in Place, Metal Deck)

Topic: Floors

Subtopic: Accessible Floors

Desired Outcome: Maintain a consistent, uniform *thermal boundary* between conditioned and unconditioned space to prescribed R-value; insulation protected on the bottom side by a weather-resistant barrier

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
4.1301.14a Pre-inspection	Conduct pre-inspection in accordance with SWS 2.0100.4 Work Area Inspection and Stabilization Gaps, cracks, and holes in fire separations located within the work area will be visually identified and incorporated into air sealing work scope, including those that span two conditioned or unconditioned spaces Where drawings are available that identify specific fire-resistance ratings (i.e., 1 hour, 2 hour), materials and methods will be employed to preserve or restore such rating Where drawings are unavailable or do not identify specific fire-resistance ratings, the fire-resistance rating of the assembly may be inferred from the current construction (i.e., single 5/8 sheetrock, concrete masonry unit), and materials and methods employed	Ensure and preserve integrity of fire separations Provide a safe and stable work environment		4661

	will be consistent with restoring or preserving such inferred fire-resistance rating Repairs necessary to stabilize work areas and protect or preserve integrity of energy improvement will be completed before subject work begins			
4.1301.14b Preparation	Health and safety concerns will be addressed for occupants, workers, and repair materials in accordance with OSHA standards (OSHA 1926, 1910) Prepare and isolate the area in accordance with health and safety standards for the application and materials (e.g., extreme temperatures, lead, asbestos, carbon monoxide) Work lighting, work platform, and adequate ventilation will be provided	Provide a safe working environment Provide a safe indoor environmental quality working environment Provide effective repair access		4662
4.1301.14c Subfloor preparation	Sealing between conditioned space and unconditioned space or exterior will be completed before insulating	Ensure airtight floor assembly		4663
4.1301.14d Installation	Insulation will be installed to prescribed R-value Insulation will be installed in contact with bottom of the floor decking without gaps, voids, compressions, misalignments, or wind intrusions If vapor retarders are used, install consistent with local climate/code requirements	Prevent potential fire chases Provide effective R-value Prevent excessive vapor migration into the floor assembly and/or conditioned space		4664
4.1301.14e Installation of batts	Batts will be installed continuously All perimeter joints will be sealed to the floor deck	Minimize convective loops Minimize sagging, gaps, and voids Protect batts from weather		4665
4.1301.14f Installation of rigid insulation	Rigid insulation will be installed continuously and mechanically fastened to the bottom of the floor deck Where rigid foam plastics are used, in no case will the final thickness exceed the manufacturer's tested thickness used to determine the maximum 75 flame spread and 450 smoke-developed index when tested to ASTM E84 or UL 723 Foam will be provided with ignition and thermal boundaries, as required by code	Minimize convective loops Minimize sagging, gaps, and voids		4666

4.1301.14g Installation of spray polyurethane foam (SPF)	SPF will be applied continuously to bottom side of floor deck, per global section for application of SPF Where rigid foam plastics are used, in no case will the final thickness exceed the manufacturer's tested thickness used to determine the maximum 75 flame spread and 450 smoke-developed index when tested to ASTM E84 or UL 723 Foam will be provided with ignition and thermal boundaries, as required by code	Minimize convective loops Minimize gaps and voids		4667
4.1301.14h Installation, if mechanicals are below the floor deck (applies to all insulation types)	All plumbing and ductwork will be enclosed within the insulated space and will have sufficient insulation on the exterior side	Prevent freezing of plumbing pipes		4668
4.1301.14i Weather-resistant barrier	A weather-resistant barrier will be applied to the weather side of the insulation (e.g., exterior insulated finishing system and spray-on roof waterproofing over foam)	Protect insulation from weather, light and impact		4669
4.1301.14j Property manager 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		4670

4.1301.15 Non-Joisted Floors Over Basements or Crawl Spaces (e.g., Pre-Cast Concrete, Poured in Place, Metal Deck)

Topic: Floors

Subtopic: Accessible Floors

Desired Outcome: Maintain a consistent, uniform thermal and *air barrier* between conditioned and unconditioned space to prescribed R-value

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		

4.1301.15a Subfloor preparation	Air sealing between conditioned space and unconditioned space will be completed before insulating	Ensure airtight floor assembly		4671
4.1301.15b Metal floor decks	Bottom side of metal deck flutes will be sealed to the insulation material at every support beam joint Top side of open metal deck flutes (e.g., flutes are not filled) will be sealed to the bottom of the floor deck at every perimeter support beam joint Bottom flutes of metal decks will be totally insulated where they cross support beams from the beam to the exterior wall	Minimize air flow bypasses between insulation and metal deck subfloor Minimize condensation on underside of metal floor deck		4672
4.1301.15c Installation	Insulation will be installed to prescribed R-value Insulation will be installed in contact with bottom of the floor decking without gaps, voids, compressions, misalignments, or wind intrusions If vapor retarders are used, they will be installed consistent with local climate/code requirements	Provide effective R-value Prevent potential fire chases Prevent excessive vapor migration into the floor assembly and/or conditioned space		4673
4.1301.15d Installation of batts and support system	Batts will be installed continuously between structural framing Batts will be installed with a support system below the insulation Support system will be mechanically fastened to the bottom side of the floor deck	Minimize convective loops Prevent sagging Minimize gaps and voids between the insulation and floor deck		4674
4.1301.15e Installation of rigid insulation and support system	Rigid insulation will be installed continuously between structural framing Rigid insulation will be installed with a support system below the insulation Support system will be mechanically fastened to the bottom side of the floor deck Where rigid foam plastics are used, in no case will the final thickness exceed the manufacturer's tested thickness used to determine the maximum 75 flame spread and 450 smoke-developed index when tested to ASTM E84 or UL 723 Foam will be provided with ignition and thermal boundaries, as required by code	Minimize convective loops Prevent sagging Minimize gaps and voids between the insulation and floor deck		4675
4.1301.15f Installation	SPF will be applied continuously to bottom side of floor deck	Minimize convective loops Minimize gaps and voids		4676

of spray polyurethane foam (SPF)	Where rigid foam plastics are used, in no case will the final thickness exceed the manufacturer's tested thickness used to determine the maximum 75 flame spread and 450 smoke-developed index when tested to ASTM E84 or UL 723 Foam will be provided with ignition and thermal boundaries, as required by code			
4.1301.15g Installation, if mechanicals are below the floor deck (applies to all insulation types)	All plumbing and ductwork will be enclosed within the insulated space and will have sufficient insulation in contact with a continuous air barrier on the exterior side	Prevent freezing of plumbing pipes		4677
4.1301.15h Property manager 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		4678

4.1403.1 Slab-Edge Foundations and Above-Grade Concrete Decks—Raised and On-Grade

Topic: Basements and Crawl Spaces

Subtopic: Slab Foundations

For supporting material, see Building America Solution Center.

Desired Outcome: Thermal break between the slab edge and outdoors and ground

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
4.1403.1a Pre-inspection	An exterior and interior inspection will be conducted for water damage, drainage plane failures, grading issues, and breaches unrelated to the specified air sealing and insulating work Repairs necessary to stabilize work areas and protect or preserve integrity of energy improvement will be completed before subject work begins	Repair moisture and structure-related issues Provide a stable slab and related assemblies to ensure the durability of the work Ensure that any underground utility services are located and protected from damage		4679

	Site will be evaluated to determine potential for excavation Identify all underground utilities entering the building in the work area			
4.1403.1b Air sealing	Air sealing between conditioned space and unconditioned space will be completed before insulating	Ensure airtight floor assembly		4680
4.1403.1c Excavation	Excavation will be done to expose the slab edge to the required depth Caution will be exercised to avoid undermining slab footing and to avoid damage of underground utilities Excavations will be weather protected (moisture and frost) and will be restored to original condition (density, drainage function) as quickly as possible	Provide below-grade installation access Protect slab and utilities from damage		4681
4.1403.1d Clean and prepare surfaces	Slab edge will be prepared for material installation to meet manufacturer specifications	Ensure a durable installation		4682
4.1403.1e Top and bottom flashing	Flashing will be continuous and permanently secured	Preserve the drainage plane of the wall		4683
4.1403.1f Installation	Insulation will be installed to prescribed R-value Insulation will be installed in contact with the slab edge, without voids, compressions, or misalignments Insulation will be run tight to any utilities penetrating the slab edge insulation	Provide effective R-value		4684
4.1403.1g Protective cover	Exposed insulation will be covered with a durable, rigid material	Protect insulation from weather and impact		4685
4.1403.1h Termites	Existing termite treatment and inspection gaps will be preserved, and termite control measures consistent with local code requirements will be implemented, as required	Prevent pest entry and maintain applicable warranties		4686
4.1403.1i Back fill	Restore excavated earth and grade to preserve drainage plane	Preserve the drainage plane of the slab edge		4687
4.1403.1j Property manager education	A dated receipt signed by the installer will be provided that includes: □ Coverage area □ Thickness □ R-value	Document job completion to contract specifications Comply with 16 CFR 460.17 Confirm amount of insulation installed		4688

4.1601.6 Insulating Metal Ducts—Low Rise

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)		
4.1601.6a 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 greater, and have an attached vapor barrier Ducts will not be buried in hot humid and warm coastal regions	Decrease heat loss and condensation problems		4689
4.1601.6b Duct sealing	Before insulation is applied, all accessible ducts will be sealed with a UL-approved mastic in conformance with the applicable code adopted by the jurisdiction	Minimize duct leakage		4690
4.1601.6c Attachment of duct insulation	Duct insulation will be secured to the duct system using an appropriate material per applicable standards that will securely hold the insulation to the ductwork, without compressing the insulation in the process	Ensure a secure connection between the duct system and the duct insulation		4691
4.1601.6d Sealing of the duct insulation	Using a tape or mastic approved by the manufacturer, all seams and connection of the duct insulation will be sealed No gaps will exist between pieces of duct insulation	Prevent gaps in the vapor barrier of the insulation		4692

4.1601.7 Insulating Metal Ducts—Mid and High Rise

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)		
4.1601.7a 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 greater, and have an attached vapor barrier	Decrease heat loss and condensation problems		4693

	Ducts will not be buried in hot humid and warm coastal regions			
4.1601.7b Duct sealing	Before insulation is applied, all accessible ducts will be sealed with a UL-approved mastic in conformance with the applicable code adopted by the jurisdiction	Minimize duct leakage		4694
4.1601.7c Attachment of duct insulation	Duct insulation will be secured to the duct system using an appropriate material per applicable standards that will securely hold the insulation to the ductwork, without compressing the insulation in the process	Ensure a secure connection between the duct system and the duct insulation		4695
4.1601.7d Sealing of the duct insulation	Using a tape or mastic approved by the manufacturer, all seams and connections of the duct insulation will be sealed No gaps will exist between pieces of duct insulation	Prevent gaps in the vapor barrier of the insulation		4696

Section 5: Heating and Cooling

5.3001.4 Equipment Selection—Low Rise

Topic: Forced Air

Subtopic: Design

Desired Outcome: Equipment sized properly and operating efficiently

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3001.4a Load calculation: heat loss or gain	Heat loss or gain of the building will be calculated considering the following: • R-values of building components • U-value and solar heat gain coefficient of glazing • Orientation and exterior shading of glazing • Duct heat loss or gain • Infiltration target or final infiltration after air sealing is completed • Ventilation • Internal gains ANSI/ACCA Manual J Residential Load Calculation, 8th ed., and	Accurately calculate sensible and latent load for the total building and each room Properly size equipment for the load		5919

	ANSI/ACCA 5 QI HVAC Quality Installation Specification requirements or ASHRAE equivalents will be used for all residential load calculations ANSI/ACCA Manual N Commercial Load Calculation or ASHRAE equivalents will be used for all commercial load calculations Room-by-room calculations will be performed when installing new duct systems or in retro-commission projects			
5.3001.4b Load calculation: design conditions of single stage or single speed equipment	Interior design temperatures will be selected based on 75° for cooling and 70° for heating, unless otherwise stated by local code Ensure the design loads reflect peak sensible and peak latent load conditions per ASHRAE Handbook—Fundamentals Design sensible loads, which will dominate in dry climates, should be based upon outdoor design cooling conditions for the location (e.g., peak cooling dry bulb temperature in the ASHRAE Handbook—Fundamentals) Design latent loads, which are most important in moist or humid climates, should be based upon design dehumidification conditions for the location (e.g., design dew point temperature and mean coincident dry bulb temperature in the ASHRAE Handbook—Fundamentals)	Accurately calculate sensible and latent load for the building Properly size equipment for the load		5920
5.3001.4c Load calculation: design conditions for multistage, variable speed equipment	Interior design temperatures will be selected based on 75° for cooling and 70° for heating, unless otherwise stated by local code Ensure the design loads reflect peak sensible and peak latent load conditions per ASHRAE Handbook—Fundamentals Design sensible loads, which will dominate in dry climates, should be based upon outdoor design cooling conditions for the location (e.g., peak cooling dry bulb temperature in the ASHRAE Handbook—Fundamentals)	Accurately calculate sensible and latent load for the building Properly size equipment for the load		5921

	Design latent loads, which are most important in moist or humid climates, should be based upon design dehumidification conditions for the location (e.g., design dew point temperature and mean coincident dry bulb temperature in the ASHRAE Handbook—Fundamentals)			
5.3001.4d Equipment selection: air conditioning and heat pumps	Equipment capable of meeting the sensible and latent load of the building will be selected using the detailed capacity tables provided by the manufacturer Equipment will not be sized by more than 115% of total load or next available size ANSI/ACCA Manual S Residential Equipment Selection, and ANSI/ACCA 5 QI HVAC Quality Installation Specification requirements or ASHRAE equivalents will be used for all residential equipment selection ANSI/ACCA Manual CS Commercial Applications Systems and Equipment or ASHRAE equivalents will be used for all commercial equipment selection	Ensure the equipment is able to heat, cool, and dehumidify the building		5922
5.3001.4e Equipment selection: auxiliary heat for heat pumps	Use the lowest capacity heating equipment required to heat the building, utilizing the detailed capacity tables provided by the equipment manufacturer Equipment will be selected to provide a changeover point, calculated using information from the detailed capacity tables provided by the equipment manufacturer, weather data, and utility cost	Maximize the heating potential of the compressor Minimize the use of auxiliary heat		5923
5.3001.4f Equipment selection: furnaces	The smallest capacity heating equipment will be selected that is capable of meeting the design heating load and providing the air movement required by the air conditioning When an air-conditioning system is not designed with the furnace, the smallest capacity heating equipment will be selected that is capable of meeting the heating load	Ensure equipment meets the heating load of the building Ensure equipment moves required air for air conditioning, if applicable		5924

	The lowest capacity cooling equipment required to cool the building will be used Equipment will not be sized by more than 115% of total load or next available size			

5.3001.5 Ductwork and Termination Design—Low Rise

Topic: Forced Air

Subtopic: Design

Desired Outcome: Efficient air flow to all rooms is ensured by proper ductwork

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

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3001.5a Sizing	Ducts will be sized to deliver the appropriate amount of airflow (both supply and return) needed to satisfy the heating and/or cooling load of the building Ducts will be sized using friction charts ANSI/ACCA Manual D Residential Duct Systems or ASHRAE equivalents will be used for all residential ductwork sizing ANSI/ACCA Manual Q Low Pressure, Low Velocity Duct System Design or ASHRAE equivalents will be used for all commercial ductwork sizing	Minimize static pressure Maximize air flow		5925
5.3001.5b Air handler to return plenum	Return plenum will be designed in accordance with ANSI/ACCA Manual D or equivalent Radius elbow fittings or square fittings with turning vanes will be used to direct return air when a 90° turn is required	Minimize static pressure Maximize air flow		5926
5.3001.5c Air handler to supply plenum	Supply plenum will be designed in accordance with ANSI/ACCA Manual D or equivalent Radius elbow fittings or square fittings with turning vanes will be installed to direct supply air Supply plenum will be the same size as the air handler supply opening	Minimize static pressure Maximize air flow		5927
5.3001.5d Building	Building cavities will not be used as ductwork in new systems	Maximize air flow Minimize energy use		5928

cavities used as ductwork	In existing systems, building cavities will be sealed and tested	Safeguard indoor air quality		
5.3001.5e Reducers	Reducers between sections of different size ducts will be in accordance with existing standards based on duct material (SMACNA, NAIMA)	Minimize static pressure Maximize air flow		5929
5.3001.5f Supply branch run outs	Runs will be installed as short as possible	Minimize static pressure Maximize air flow		5930
5.3001.5g Boots	If using flexible duct with straight boots, duct will be connected to boot with no bend A rigid elbow will be used when a flexible duct changes direction A rigid connector will be used when joining two pieces of flexible duct together	Minimize static pressure Maximize air flow		5931
5.3001.5h Supply terminations	Terminations will be selected based on ACCA Manual T Air Distribution Basics	Minimize static pressure Maximize air flow		5932
5.3001.5i Return grille sizing	Terminations will be selected based on ACCA Manual T Air Distribution Basics Grille gross area will be equal to or larger than return box	Minimize static pressure Maximize air flow		5933
5.3001.5j Manual volume dampers	Dampers will be installed as close to the trunk as possible while still being accessible to allow for adjustment after interior finishes are installed	Minimize static pressure and noise Maximize air flow		5934
5.3001.5k Flexible ducts	Flexible ducts will not be bent more than 45° without rigid elbow	Minimize static pressure Maximize air flow		5935
5.3001.5l Take-offs	Take-offs that create high turbulence will not be used (e.g., elbows with integrated dampers, scoops) Take-offs will be installed onto the trunk in accordance with duct construction standards (SMACNA)	Minimize static pressure Maximize air flow		5936
5.3001.5m Fire dampers	Fire dampers shall be installed as required by applicable fire code	Minimize static pressure Maximize air flow		5937

5.3001.6 Load Calculation and Equipment Selection—Mid and High Rise

Topic: Forced Air

Subtopic: Design

Desired Outcome: Equipment sized properly and operating efficiently

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3001.6a Load calculation: heat loss or gain	Heat loss or gain of the building will be calculated considering the following: • R-values of building components • U-value and solar heat gain coefficient of glazing • Orientation and exterior shading of glazing • Duct heat loss or gain • Infiltration target or final infiltration after air sealing is completed • Ventilation • Internal gains ANSI/ACCA Manual J Residential Load Calculation, 8th ed. and ANSI/ACCA 5 QI HVAC Quality Installation Specification requirements or ASHRAE equivalents will be used for all residential load calculations ANSI/ACCA Manual N Commercial Load Calculation or ASHRAE equivalents will be used for all commercial load calculations Room-by-room calculations will be performed when installing new duct systems or in retro-commission projects	Accurately calculate sensible and latent load for the total building and each room Properly size equipment for the load		5938
5.3001.6b Equipment selection	ANSI/ACCA Manual S Residential Equipment Selection and ANSI/ACCA 5 QI HVAC Quality Installation Specification requirements or ASHRAE equivalents will be used for all residential equipment selection ANSI/ACCA Manual CS Commercial Applications Systems and Equipment or ASHRAE equivalents will be used for all commercial equipment selection	Ensure equipment is able to heat, cool, and dehumidify the building		5939

5.3001.6c Variable refrigerant flow selection	When applicable, multiple indoor units will be supplied by a single outdoor unit When applicable, manufacturer specifications will be used to determine allowable overage of indoor unit capacity in relation to the outdoor unit When applicable, units will be selected that offer ducting options (e.g., ceiling cassette units have a knock out for a 5" or 6" duct) When applicable, units with an outdoor air intake will be selected When design temperature is less than temperatures in the capacity tables, units will be derated in accordance with manufacturer specifications	Ensure equipment operates at optimal efficiency		5940
5.3001.6d Ductless mini split selection	When applicable, multiple indoor units will be supplied by a single outdoor unit When applicable, manufacturer specifications will be used to determine allowable overage of indoor unit capacity in relation to the outdoor unit When applicable, units will be selected that offer ducting options (e.g., ceiling cassette units have a knock out for a 5" or 6" duct) When applicable, units with an outdoor air intake will be selected	Reduce total system cost Ensure equipment operates at optimal efficiency		5941
5.3001.6e Package terminal air conditioner (PTAC) or package terminal heat pump selection	Package unit will be selected with outdoor air intake unless other ventilation strategy is present Primary heating of newly installed PTAC units will not be electric resistance heat	Ensure equipment operates at optimal efficiency		5942
5.3001.6f Cooling towers (rain water option) selection	Elevation of tower will be selected in relation to the net positive suction head required at the pump and in accordance with manufacturer specifications	Ensure equipment operates at optimal efficiency		5943
5.3001.6g Economizer selection	The need for an economizer outdoor air damper will be determined in	Ensure occupant health		5944

	accordance with ASHRAE 90.1 minimum requirements or local code			

5.3002.12 Cooling Equipment—Installation, Maintenance, and Commissioning— Mid and High Rise

Topic: Forced Air

Subtopic: Site Preparation

Desired Outcome: Equipment operates effectively and efficiently

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3002.12a Chiller installation	Maximum weight of refrigerant in a single space will be in compliance with ASHRAE Refrigerant monitors will be installed in accordance with ASHRAE Refrigerant relief valve will be piped to the outdoors and have an alarm Unit operational efficiencies will meet minimums as required by ASHRAE 90.1 Structure will be able to support the unit Vibration isolators will be provided Manufacturer requirements will be followed when alternative storage methods for cooling towers are used (e.g., ice storage, ice tanks)	Reduce vibration to a non-objectionable level Ensure optimum performance		5962
5.3002.12b Chiller maintenance	Maintenance will be scheduled in accordance with ANSI/ACCA/ASHRAE Standard 180 Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems Maintenance procedures include, but are not limited to, the following: • Tubes will be checked annually • Electrical check of system will be performed • Manufacturer-recommended maintenance procedures will be performed	Ensure proper chiller maintenance		5963

	• Proper operation of leak detectors will be verified • Refrigerant charge will be verified			
5.3002.12c Chiller commissioning	Unit discharge temperature will be verified as called for by control system in accordance with the design documents Inlet and outlet temperatures to condenser will be maintained in accordance with the design documents Noise level will be maintained to be within designed criteria Safety switches will be verified to operate when unsafe conditions occur	Ensure optimum performance		5964
5.3002.12d Split system installation	Condensate will be piped to a properly sized sanitary drain Refrigerant type will be acceptable to the project type Unit operational efficiencies will meet minimums as required by ASHRAE 90.1 Structure will be able to support the unit Each unit will be installed with a properly trapped condensate drain in accordance with manufacturer specifications (some situations require a pump) Primary heating of newly installed split systems will not be electric resistance heat Smoke detectors will be installed on systems that are greater than 2,500 cubic feet per minute (CFM) Appropriate lengths and elevations of refrigerant lines between condensing units and indoor coil will be used in accordance with manufacturer specifications Proper location (e.g., property lines, windows, units, outside air intakes) and clearances will be maintained in accordance with manufacturer specifications Environmental conditions will be considered when selecting and installing coils (e.g., special corrosion-protected units)	Ensure proper installation of split system		5965

5.3002.12e Split system maintenance	Maintenance will be scheduled in accordance with ANSI/ACCA/ASHRAE Standard 180 Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems Maintenance procedures include, but are not limited to, the following: Filters will be replaced in accordance with manufacturer specifications Annual cleaning of coil and drain pan will be performed Condensate drains/traps will be inspected and verified operational Proper operation of add-on equipment will be verified (e.g., UV, humidifier, electrostatic filter)	Ensure proper maintenance of system		5966
5.3002.12f Split system commissioning	Proper operation of thermostats will be verified Carbon dioxide (CO2) sensors will be calibrated Proper operation of smoke alarms will be verified Proper operation of mixed air damper will be verified If present, proper operation of heating valve will be verified Drains will be clear of debris and obstructions	Ensure optimum performance		5967
5.3002.12g Package system unit installation	Economizer (if installed) will be located away from pollutant sources Condensate will be piped to a properly sized sanitary drain Type of refrigerant will be verified as acceptable to the project type Economizer/power exhaust or relief dampers will be verified for proper function and operation Unit operational efficiencies will meet minimums as required by ASHRAE 90.1 Structure will be able to support the unit Each unit will be installed with a properly trapped condensate drain in accordance with manufacturer specifications (some situations require a pump)	Ensure equipment operates at optimal efficiency Ensure durability of equipment Minimize energy use Minimize health concerns (e.g., Legionnaires' disease)		5968

	New package systems will not have their primary heating be electric resistance heat Unit will be installed with CO2 control in high occupancy spaces (demand control ventilation) Smoke detectors will be installed on systems that are greater than 2,500 CFM Proper location (e.g., property lines, windows, units, outside air intakes) and clearances will be maintained in accordance with manufacturer specifications			
5.3002.12h Package system unit maintenance	Maintenance will be scheduled in accordance with ANSI/ACCA/ASHRAE Standard 180 Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems Maintenance procedures include, but are not limited to, the following: • Filters will be replaced in accordance with manufacturer specifications • If applicable, blower belt, sheaves replacement, and alignment will be verified • If applicable, proper operation of the variable speed drive will be verified • Annual cleaning of evaporator and condenser coils, condensate trap, and drain pan will be performed Proper operation of add-on equipment will be verified (e.g., UV, humidifier, electrostatic filter) Environmental conditions will be considered when selecting and installing coils (e.g., special corrosion-protected units)	Ensure proper maintenance of equipment		5969
5.3002.12i Package system unit commissioning	Before commissioning startup, test and balance reports will be provided Thermostats or building automation control will be verified to be functioning properly Properly working sequence of operations will be verified Properly functioning outdoor air, return air, supply air, CO2, and	Ensure optimum performance		5970

	enthalpy sensor will be verified (if installed) Proper operation of mixed air damper will be verified Proper operation of reversing valve will be verified in heat pump units Drains will be clear of debris and obstructions Proper operation of motorized dampers will be verified In 3-phase units, the correct rotation of blower, condenser fans, and compressor will be verified Correct voltage level coming into unit will be verified Proper heating and cooling operation will be verified as in accordance with manufacturer specifications In heat pumps, proper defrost cycle operation will be verified Proper operation of safety switches will be verified			
5.3002.12j Variable refrigerant flow (VRF) installation	Building electrical characteristics, such as voltage and phase, will be checked to ensure proper equipment is selected Maximum weight of refrigerant in a single space will not exceed the maximum allowed by ASHRAE Total equivalent length of refrigerant piping will not exceed manufacturer rating Proper location and clearances will be maintained in accordance with manufacturer specifications Each unit will be installed with a condensate drain (some situations require a pump) Wall-mounted thermostats will be used Location of branch controller will be selected for non-occupied areas Outdoor air ventilation filter will be present	Reduce noise		5971
5.3002.12k VRF maintenance	Filters will be replaced in accordance with manufacturer specifications Annual cleaning of indoor and outdoor coils will be performed	Ensure proper maintenance		5972

	Environmental conditions will be considered when selecting and installing coils (e.g., special corrosion-protected units)			
5.3002.12l VRF commissioning	Thermostats will be verified to be functioning properly If installed, operation of ventilation damper will be verified Proper refrigerant charge will be verified Power supply will be verified (single phase units supply power from the outdoor units to the indoor units)	Reduce total system cost Ensure equipment operates at optimal efficiency Ensure equipment durability		5973
5.3002.12m Ductless mini split installation	System will be a ductless mini split and not a VRF system Ductwork will not be installed Building phase will be checked to ensure proper equipment is selected Total equivalent length of refrigerant piping will not exceed manufacturer specifications Proper location and clearances will be maintained in accordance with manufacturer specifications Each unit will be installed with a condensate drain (some situations require a pump) Wall-mounted thermostats will be used	Reduce total system cost Ensure equipment operates at optimal efficiency Ensure equipment durability		5974
5.3002.12n Ductless mini split maintenance	Maintenance will be scheduled in accordance with ANSI/ACCA/ASHRAE Standard 180 Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems Maintenance procedures include, but are not limited to, the following: • Filters will be replaced in accordance with manufacturer specifications • Annual cleaning of indoor and outdoor coils will be performed	Reduce total system cost Ensure equipment operates at optimal efficiency Ensure equipment durability		5975
5.3002.12o Ductless mini split commissioning	Thermostats will be verified to be functioning properly Ventilation damper will be operational if outside air ducting is available, and airflow will be	Reduce total system cost Ensure equipment operates at optimal efficiency Ensure equipment durability		5976

	adjusted to provide the proper amount			
5.3002.12p Package terminal air conditioner (PTAC) or package terminal heat pump (PTHP) installation	PTAC sleeve will be sealed to envelope Condensate will be piped away from the building when required by manufacturer specifications Ducted PTACs will be used for conditioning multiple rooms Structure will be able to support the unit PTAC will be selected with outdoor air intake unless other ventilation strategy is present Each unit will be installed with a condensate drain (some situations require a pump) Environmental conditions will be considered when selecting and installing coils (e.g., special corrosion-protected units)	Ensure equipment operates at optimal efficiency Ensure equipment durability		5977
5.3002.12q PTAC or PTHP maintenance	Maintenance will be scheduled in accordance with ANSI/ACCA/ASHRAE Standard 180 Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems Maintenance procedures include, but are not limited to, the following: • Filters will be replaced in accordance with manufacturer specifications • Drains will be clear of debris and obstructions • Annual cleaning of coils will be performed	Ensure equipment operates at optimal efficiency Ensure equipment durability		5978
5.3002.12r PTAC or PTHP commissioning	Thermostats will be verified to be functioning properly Ventilation damper will be operational if outside air ducting is available If present, proper operation of heating valve will be verified Drains will be clear of debris and obstructions	Ensure equipment operates at optimal efficiency Ensure equipment durability		5979
5.3002.12s Cooling towers installation	Location of unit will minimize overspray and noise impact on neighboring properties Overspray will not be directed toward air intakes	Ensure equipment operates at optimal efficiency Ensure durability of equipment Minimize energy usage		5980

	Structure will be able to support the unit Vibration isolators will be provided Elevation of tower will be selected in relation to the net positive suction head required at the pump and in accordance with manufacturer specifications Appropriate drainage will be available in accordance with local code Capacity control will be in accordance with the sequence of operations (e.g., two-speed or variable speed) Manufacturer specifications will be followed when alternative storage methods are used (e.g., ice storage, ice tanks) Environmental design conditions will account for sump heaters, water treatment requirements, conservation regulations, and possible restrictions of usage	Minimize health concerns (e.g., Legionnaires' disease)		
5.3002.12t Cooling towers (rain water option) maintenance	Maintenance will be scheduled in accordance with ANSI/ACCA/ASHRAE Standard 180 Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems Maintenance procedures include, but are not limited to, the following: • Manufacturer-recommended maintenance procedures will be performed • Media will be cleaned • Strainers will be cleaned • Motors and/or belts will be serviced • Drains will be clear of debris and obstructions • Water treatment levels will be maintained • Debris will be cleaned from sump • Annual cleaning of coils will be performed • Structural supports will be checked	Ensure equipment operates at optimal efficiency Ensure durability of equipment Minimize energy use Minimize health concerns (e.g., Legionnaires' disease)		5981

5.3002.12u Cooling towers commissioning	Unit installed to manufacturer specifications will be verified Secondary overflow drain operation will be verified Proper operation of make-up water level detector will be verified If multitowers exist, proper operation of the equalizer line will be verified If applicable, proper sump heater operation will be verified Proper installation of water treatment will be verified If rain water system is used, proper operation of controls will be verified Proper installation of tower fill media will be verified Capacity controls operating in accordance with the sequence of operations will be verified If applicable, proper operation of submeter will be verified	Ensure equipment operates at optimal efficiency Ensure durability of equipment Minimize energy use Minimize health concerns (e.g., Legionnaires' disease)		5982
5.3002.12v Economizers installation	Economizer, if installed, will be located away from pollutant sources Need for economizer outdoor air damper will be determined in accordance with ASHRAE 90.1 minimum requirements or local code Unit will be installed with carbon dioxide (CO2) control in high occupancy spaces (demand control ventilation) If unit economizer is part of fire life safety function, it will be tested for proper operation and control Economizer, power exhaust, or relief dampers will be verified for proper function and operation	Minimize health concerns Ensure equipment operates at optimal efficiency Ensure durability of equipment		5983
5.3002.12w Economizers maintenance	Maintenance will be scheduled in accordance with ANSI/ACCA/ASHRAE Standard 180 Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems Maintenance procedures include, but are not limited to, the following: CO2 and temperature/enthalpy sensors will be calibrated Smoke detector operation will be verified	Minimize health concerns Ensure equipment operates at optimal efficiency Ensure durability of equipment		5984

	Proper motorized damper operation will be verified Lubrication and damper linkage adjustments will be maintained			
5.3002.12x Economizers commissioning	Properly working sequence of operations will be verified based on manufacturer specifications Proper operation of the outdoor air, return air, supply air, CO2, and enthalpy sensor will be verified based on manufacturers specifications Proper operation of mixed air damper will be verified based on manufacturer specifications Proper operation of motorized dampers will be verified based on manufacturer specifications Smoke detector and CO2 sensor interaction with the damper will be verified based on manufacturer specifications Pressure relief system will be verified as working when economizer is open	Minimize health concerns Ensure equipment operates at optimal efficiency Ensure durability of equipment		5985
5.3002.12y Water source heat pump installation	Condensate will be piped to a properly sized sanitary drain Type of refrigerant will be acceptable to the project type Unit operational efficiencies will meet minimums as required by ASHRAE 90.1 Structure will be able to support the unit Each unit will be installed with a properly trapped condensate drain in accordance with manufacturer specifications (some situations require a pump) Unit will be installed with CO2 control in high occupancy spaces (demand control ventilation) Smoke detectors will be installed on systems that are greater than 2,500 CFM Two-way valves will be installed that open when the thermostat calls for heating or cooling	Minimize health concerns Ensure equipment operates at optimal efficiency Ensure durability of equipment		5986
5.3002.12z Water source	Maintenance will be scheduled in accordance with ANSI/ACCA/ASHRAE Standard	Minimize health concerns Ensure equipment operates at optimal efficiency		5987

heat pump maintenance	180 Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems Maintenance procedures include, but are not limited to, the following: Filters will be replaced in accordance with manufacturer specifications Annual cleaning of the coil and drain pan will be performed Proper operation of add-on equipment will be verified (e.g., UV, humidifier, electrostatic filter) Thermostats will be verified to be functioning properly CO2 sensor will be calibrated Smoke detector operation will be verified Environmental conditions will be considered when selecting and installing coils (e.g., special corrosion-protected units)	Ensure durability of equipment		
5.3002.12aa Water source heat pump commissioning	Thermostats will be verified to be functioning properly Proper operation of mixed air damper will be verified Proper operation of two-way valve will be verified Drains will be clear of debris and obstructions	Minimize health concerns Ensure equipment operates at optimal efficiency Ensure durability of equipment		5988
5.3002.12ab Fan coil units installation	Four-pipe systems, where applicable, will be installed in order to take advantage of simultaneous heating and cooling Condensate will be piped to a properly sized sanitary drain Adequate structural support will be verified for unit Each unit will be installed with a properly trapped condensate drain in accordance with manufacturer specifications (some situations require a pump) Unit will be installed with CO2 control in high occupancy spaces (demand control ventilation) Filtration minimum efficiency reporting value (MERV) level will be appropriate for type of space and equipment	Ensure equipment operates at optimal efficiency Ensure durability of equipment Minimize energy usage Minimize health concerns (e.g., Legionnaires' disease)		5989

	If the building operates with a pneumatic system, the following components will be serviced and maintained: air compressor, air dryer system, thermostats, actuators, receiver controllers, sensors, and miscellaneous components, such as pneumatic electric, electric pneumatic solenoid, and solenoid switches			
5.3002.12ac Fan coil units maintenance	Maintenance will be scheduled in accordance with ANSI/ACCA/ASHRAE Standard 180 Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems Maintenance procedures include, but are not limited to, the following: Filters will be replaced in accordance with manufacturer specifications Annual cleaning of the coil and drain pan will be performed Proper operation of add-on equipment will be verified (e.g., UV, humidifier, electrostatic filter) Thermostats will be verified to be functioning properly CO2 sensor will be calibrated Smoke detector operation will be verified Environmental conditions will be considered when selecting and installing coils (e.g., special corrosion-protected units)	Ensure equipment operates at optimal efficiency Ensure durability of equipment Minimize energy use Minimize health concerns (e.g., Legionnaires' disease)		5990
5.3002.12ad Fan coil units commissioning	Thermostats will be verified to be functioning properly If applicable, proper operation of heating and cooling valve will be verified Drains will be clear of debris and obstructions	Ensure equipment operates at optimal efficiency Ensure durability of equipment Minimize energy use Minimize health concerns (e.g., Legionnaires' disease)		5991
5.3002.12ae Wall furnace installation	Penetrations through exterior walls will be sealed with the appropriate air sealing material Adequate structural support will be verified for unit A carbon monoxide detector will be installed in the rooms where the wall furnace is located	Ensure occupant health and safety Ensure system efficiency		5992

	Filtration MERV level will be appropriate for type of space and equipment			
5.3002.12af Wall furnace maintenance	Maintenance will be scheduled in accordance with ANSI/ACCA/ASHRAE Standard 180 Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems Maintenance procedures include, but are not limited to, the following: Filters will be replaced in accordance with manufacturer specifications Thermostats will be verified to be functioning properly	Ensure equipment operates at optimal efficiency Ensure durability of equipment Minimize energy use		5993
5.3002.12ag Wall furnace commissioning	Thermostats will be verified to be functioning properly Filters will be verified to be clear of debris Temperature rise will be within manufacturer specifications Gas pressure will be within manufacturer specifications A combustion analysis test will be performed and documented	Ensure equipment operates at optimal efficiency Ensure durability of equipment Minimize energy use		5994

5.3002.13 Preparation for New Equipment—Mid and High Rise

Topic: Forced Air

Subtopic: Site Preparation

Desired Outcome: Existing equipment is removed safely and in accordance with local code

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

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3002.13a Access	A code compliant walkway and service platform will be installed as applicable if not present Walkway and platform will be above the level of the insulation if located in the attic	Ensure new equipment can be installed and serviced Maintain adequate insulation level		5995
5.3002.13b Environmental hazards	If mold covering more than 3 square feet is found to be present, it must be tested by a certified organization, and all system components and	Protect workers and occupants from injury		5996

	possible disturbed surrounding areas will be certified free of mold by a licensed professional before equipment removal can begin. If a friable asbestos-like substance is found to be present in an area that will be disturbed by work, it must be tested by a certified organization, and all system components and possible disturbed surrounding areas will be certified free of asbestos by a licensed professional before equipment removal can begin			
5.3002.13c Disconnection of utilities	Electricity and fuel will be turned off	Protect workers and occupants from injury		5997
5.3002.13d Refrigerant recovery	Refrigerant will be recovered in accordance with 40CFR 608 (EPA) All work will be done by a licensed professional or qualified person	Comply with Safe Handling of Refrigerant Law Protect workers and occupants from injury		5998
5.3002.13e Disconnection of equipment	Refrigerant lines, plumbing, ducts, electric, control wires, vents, and fuel supply will be disconnected All work will be done by a licensed professional	Ensure the equipment can be removed		5999
5.3002.13f Removal	Equipment will be removed (e.g., furnace, air handler, evaporator, condensing unit) Existing equipment will be able to be physically removed from building if needed in the future Equipment will be removed from the space without damaging property and disturbing or compressing the insulation Equipment will be disposed of in accordance with local laws and regulations	Safely remove the existing equipment Provide room to install new equipment and work safely Comply with disposal laws in accordance with local ordinances		6000

5.3002.16 Setting of Air Handler—Mid and High Rise

Topic: Forced Air

Subtopic: Site Preparation

Desired Outcome: Air handler is set properly in an appropriate place

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

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3002.16a Location	Equipment will be installed in a dry location within the conditioned space when feasible Equipment will be properly isolated from pollutant sources Equipment will be installed in a manner to provide ease of access for routine maintenance/service All work will be done by a licensed professional or qualified person	Prevent rust and corrosion Protect the equipment from bulk water and moisture Prevent exposure to air pollutants		6001
5.3002.16b Clearance	Equipment will be installed with proper clearances in accordance with local codes and manufacturer specifications Alternative locations will be considered for equipment when existing locations are not suitable	Ensure the equipment has proper clearances for fire risk and accessibility Ensure the equipment operates as designed		6002
5.3002.16c Connections	Equipment will be installed so connections allow proper operation of the equipment and accessibility (e.g., electrical service, condensate drains, ductwork, fuel, venting, refrigerant lines) Equipment will be installed so that the drain pan operates properly	Ensure connections do not interfere with operation and service of the equipment		6003
5.3002.16d Support: horizontal air flow, attics, and other spaces	Equipment will be supported with a nonwicking, fireproof platform or suspended with a threaded rod in accordance with local codes and manufacturer specifications Vibration pads/isolators will be installed	Ensure equipment is stable, level, and does not transmit vibration Avoid compressing or disturbing attic insulation		6004
5.3002.16e Support: horizontal air flow and basement	Equipment will be supported with a nonwicking, fireproof material or suspended with a threaded rod in accordance with local codes and manufacturer specifications Connection to structure will be enough to support weight Vibration pads/isolators will be installed	Ensure equipment is stable, level, and does not transmit vibration Avoid compressing or disturbing insulation		6005
5.3002.16f Support: up flow on a platform	Equipment will be supported on nonflammable material capable of supporting the weight of the equipment Air handler opening will be free of obstructions Vibration pads/isolators will be installed	Ensure equipment is stable, level, and does not transmit vibration Properly support equipment Prevent a fire hazard Ensure platform does not impede air flow		6006

5.3002.16g Support: down flow	Equipment will be supported on ductwork capable of supporting the weight of the equipment Equipment will be supported on ductwork with rigid exterior insulation fastened to the ductwork	Properly support equipment Protect equipment from moisture damage Reduce heat loss		6007
5.3002.16h Sealing	Gaps larger than 1/4" between air handler and adjoining ductwork or equipment (e.g., evaporator coil, filter rack) will be bridged with sheet metal, and sealed with mastic and fiberglass mesh All air handler joints will be sealed with mastic and fiberglass mesh Air handler joints and non-service openings will be sealed to eliminate all gaps with NFPA 90A and B approved sealant If unit is installed in a building cavity, the cavity must be sealed prior to the installation to eliminate any return air leaks from adjoining chases	Ensure air handler does not leak air Ensure sealing is durable Do not increase resistance to air flow		6008
5.3002.16i Drainage	A secondary drain pan that provides proper pitch and a float switch will be installed beneath equipment located in areas where water damage may occur, such as attics and conditioned spaces The float switch will be interlocked with the cooling circuit in order to turn off the equipment when a leak occurs	Prevent water damage		6009

5.3002.2 Sequence of Operation—Low Rise

Topic: Forced Air

Subtopic: Site Preparation

Desired Outcome: Sequence of operation of the system verified

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3002.2a Verification	The sequence of operation of the system will be verified in accordance with the manufacturer's installation, operation, and maintenance manuals	Ensure system components function and operate in the correct sequence		5945

5.3002.3 Sequence of Operation—Mid and High Rise

Topic: Forced Air

Subtopic: Site Preparation

Desired Outcome: Sequence of operation is functionally tested

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3002.3a Verification	Sequence of system operation will be verified in accordance with the design documents, and the manufacturer's installation, operation, and maintenance manuals	Ensure system components function and operate in the correct sequence		5946

5.3002.4 Preparation for New Equipment—Low Rise

Topic: Forced Air

Subtopic: Site Preparation

Desired Outcome: Existing equipment removed safely and in accordance with local ordinances

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

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3002.4a Access	A code-compliant walkway and service platform will be installed in attics as applicable, if not present Walkway and platform will be above the level of insulation	Ensure new equipment can be installed and serviced Maintain adequate insulation level		5947
5.3002.4b Environmental hazards	If suspected mold is found, determine the source and cause, repair issues and remove the suspected mold If a friable asbestos-like substance is found to be present in an area that will be disturbed by work, it must be tested by a certified organization, and all system components and possible disturbed surrounding areas will be certified free of asbestos by a licensed professional before equipment removal can begin	Protect workers and occupants from injury Remediate health hazards using certified contractors		5948
5.3002.4c Disconnection of utilities	Electricity and fuel will be turned off	Protect workers and occupants from injury		5949
5.3002.4d Refrigerant recovery	Refrigerant will be recovered in accordance with 40CFR 608 (EPA) All work will be done by a licensed professional or qualified person	Limit the release of ozone-depleting substances Protect workers and occupants from injury		5950

5.3002.4e Disconnection of equipment	Refrigerant lines, plumbing, ducts, electric, control wires, vents, and fuel supply will be disconnected All work will be done by a licensed professional or qualified person	Ensure equipment can be removed		5951
5.3002.4f Removal	Equipment will be removed (e.g., furnace, air handler, evaporator, condensing unit) Equipment will be removed from the space without damaging property and disturbing or compressing the insulation Equipment will be disposed of in accordance with local ordinances and regulations	Provide room to install new equipment and work safely Comply with disposal laws in accordance with local ordinances		5952

5.3002.7 Setting of Air Handler—Low Rise

Topic: Forced Air

Subtopic: Site Preparation

Desired Outcome: Air handler set properly in an appropriate place

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 Building America Solution Center.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3002.7a Location	Equipment will be installed in a dry location within the conditioned space when feasible Equipment will be properly isolated from pollutant sources (e.g., garages) Equipment will be installed in a manner to provide ease of access for routine maintenance/service All work will be done by a licensed professional or qualified person	Prevent rust and corrosion Protect equipment from bulk water and moisture Prevent exposure to garage air pollutants Ensure that equipment is maintained/serviced		5953
5.3002.7b Clearance	Equipment will be installed with proper clearances in accordance with local codes and manufacturer specifications Alternative locations will be considered for equipment when existing locations are not suitable	Ensure equipment has proper clearances for fire risk and accessibility Ensure equipment operates as designed		5954
5.3002.7c Connections	Equipment will be installed so connections allow proper operation of the equipment and accessibility (e.g., electrical service, condensation	Ensure connections do not interfere with the operation and service of the equipment		5955

	drains, ductwork, fuel, venting, refrigerant lines) Equipment will be installed so the drain pan operates properly			
5.3002.7d Support: horizontal air flow, attic	Equipment will be supported with a nonwicking fireproof platform or suspended with a threaded rod in accordance with local codes and manufacturer specifications Equipment will be placed on vibration pads	Ensure equipment is stable, level, and does not transmit vibration Avoid compressing or disturbing attic insulation		5956
5.3002.7e Support: horizontal air flow, basement, or crawl space	Equipment will be supported with a nonwicking, fireproof material or suspended with a threaded rod in accordance with local codes and manufacturer specifications Equipment will be placed on vibration pads	Ensure equipment is stable, level, and does not transmit vibration Avoid compressing or disturbing insulation		5957
5.3002.7f Support: up flow on a platform	Equipment will be supported on nonflammable material capable of supporting the weight of the equipment Air handler opening will be free of obstructions Equipment will be placed on vibration pads	Properly support the equipment Prevent a fire hazard Ensure platform does not impede air flow		5958
5.3002.7g Support: down flow	Equipment will be supported on ductwork capable of supporting the weight of the equipment Equipment will be supported on ductwork with rigid exterior insulation fastened to the ductwork	Properly support equipment Protect equipment from moisture damage Reduce heat loss		5959
5.3002.7h Sealing	Gaps larger than 1/4" between air handler and adjoining ductwork or equipment (e.g., evaporator coil, filter rack) will be bridged with sheet metal, and sealed with mastic and fiberglass mesh All air handler joints will be sealed with mastic and fiberglass mesh Air handler joints and non-service openings will be sealed to eliminate all gaps with NFPA 90A and B approved sealant If unit is installed in a building cavity, the cavity must be sealed prior to the installation to eliminate any return air leaks from adjoining chases	Ensure air handler does not leak air Ensure the sealing is durable Prevent increased resistance to air flow		5960

5.3002.7i Drainage	A secondary drain pan and drain line that provides proper pitch and a float switch will be installed beneath equipment located in areas where water damage may occur, such as attics and conditioned spaces Float switch will be interlocked with the cooling circuit to disable AC when leak occurs	Prevent water damage		5961

5.3003.17 Data Plate Verification—Low Rise

Topic: Forced Air

Subtopic: System Assessment and Maintenance

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

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3003.17a Data plate verification	Equipment will be visually inspected Information will be recorded from the indoor and outdoor equipment data plates Information will be entered into the operations and management manual	Ensure technician has equipment data necessary for commissioning and future service work		6010

5.3003.18 Leak Detection—Low Rise

Topic: Forced Air

Subtopic: System Assessment and Maintenance

Desired Outcome: Dangerous leaks detected before causing injury to the occupant or damage to the building

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3003.18a Carbon monoxide (CO) detection	Personal CO alarm will be worn in accordance with Building Performance Institute standards	Protect workers and occupants from possible CO poisoning		6011
5.3003.18b Gas leak detection	Gas pipes will be tested for leaks with an electronic combustible gas leak detector and verified with bubble solution When installing new gas lines a code approved standing pressure test will be conducted to detect leaks	Ensure gas lines do not leak		6012

5.3003.18c Fuel oil leak detection	Oil tank, piping and equipment will be visually inspected for oil leaks Fuel oil tanks will be inspected for leaks and corrosion	Ensure fuel oil lines and tanks do not leak		6013

5.3003.19 Refrigerant Line Inspection—Low Rise

Topic: Forced Air

Subtopic: System Assessment and Maintenance

Desired Outcome: Refrigerant lines properly installed

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3003.19a Insulation	All refrigerant lines will be insulated based on the equipment manufacturer's requirements in conformance with applicable code adopted by the jurisdiction All installed insulation will be properly sealed	Ensure refrigerant lines do not gain excessive heat		6014
5.3003.19b Ultraviolet (UV) protection of insulation	If exposed to sunlight, refrigerant line insulation will be protected from UV degradation	Install insulation so it does not degrade		6015
5.3003.19c Sizing	Refrigerant lines will be sized to meet manufacturer specifications for the installed equipment	Ensure system moves the appropriate volume of refrigerant		6016
5.3003.19d Installation quality	Refrigerant lines will be installed without kinks, crimps, or excessive bends Refrigerant lines will be joined together using manufacturer-approved method(s) Proper filter dryer(s) will be installed Refrigerant lines will be checked for leaks following EPA Section 608 and verified leak free before refrigerant charging Proper evacuation and dehydration techniques will be employed prior to refrigerant charging	Ensure system moves the appropriate volume of refrigerant Ensure contaminates to not harm the system Ensure the system is durable		6017
5.3003.19e Support	Refrigerant lines will be routed, supported, and secured to the building 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		6018

5.3003.20 Electrical Service—Low Rise

Topic: Forced Air

Subtopic: System Assessment and Maintenance

Desired Outcome: Electrical components properly tested

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3003.20a Polarity	Polarity of the equipment will be correct	Ensure equipment operates as designed Ensure equipment operates safely		6019
5.3003.20b Voltage: incoming power	Voltage will be in accordance with manufacturer specifications	Ensure equipment operates as designed		6020
5.3003.20c Wire size	Wire size should be appropriate for the equipment installed	Ensure equipment operates as designed Ensure equipment operates safely		6021
5.3003.20d Service disconnect	The proper service disconnect will be installed, and if fused, the correct fuses will be installed	Ensure equipment operates safely		6022
5.3003.20e Voltage: contactor	Voltage drop will be within acceptable range in accordance with manufacturer specifications	Ensure contactor does not overheat Ensure equipment operates as designed		6023
5.3003.20f Grounding	Adequate grounding will be present	Ensure equipment operates as designed Ensure equipment operates safely		6024
5.3003.20g Blower amperage	Amperage will be within original equipment manufacturer (OEM) specifications and/or code requirements	Ensure equipment operates as designed Ensure equipment operates efficiently Ensure equipment operates safely		6025
5.3003.20h Compressor amperage	Amperage will be within OEM specifications and/or code requirements	Ensure equipment operates as designed Ensure equipment operates efficiently Ensure equipment operates safely		6026
5.3003.20i Door switch operation	Blower compartment safety switch operation will be verified	Ensure blower does not operate during service		6027
5.3003.20j Heat pump: emergency heat	Emergency heat circuit functions will be verified Amperage will be within OEM specifications and/or code requirements	Ensure system delivers heat in case of a compressor failure		6028

5.3003.21 Air Flow—Low Rise

Topic: Forced Air

Subtopic: System Assessment and Maintenance

Desired Outcome: Air flow is properly tested

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3003.21a Validate air distribution system installation	System will be checked for existence of specified system components	Confirm installed system Become familiar with system components Verify system readiness for testing		6029
5.3003.21b Testing equipment selection	Measurement equipment will be selected so that design value will be within the accurate range of the measuring device Equipment will be capable of accurately measuring +/- 10% in general case Measurement equipment will be calibrated and field checked in accordance with manufacturer recommendations	Ensure accurate measurements of airflow rates		6030
5.3003.21c Test air handler unit	Equipment testing will check for: • Proper operation (programmed schedule/sequence of operation) • Proper rotation All measured values will be recorded and compared against design specifications Fan flow will be adjusted to meet design specification	Verify performance of air handler system		6031
5.3003.21d Total air flow	Total system airflow will be measured in accordance with ANSI/ACCA Standard 5 or ANSI/ASHRAE Standard 111 and adjusted to meet design requirements Examples of acceptable methods include the following: • Temperature rise test • Air flow plate (e.g., TrueFlow® Air Handler Flow Meter) • Fan pressurization device (e.g., Duct Blaster®, DuctTester) • Hot wire anemometer	Ensure equipment operates as designed Ensure equipment operates efficiently Ensure equipment provides comfort Ensure equipment operates safely Ensure equipment is durable		6032

5.3003.21e External static pressure	External static pressure will be in accordance with manufacturer specifications	Ensure equipment operates as designed Ensure equipment operates efficiently Ensure equipment provides comfort Ensure equipment operates safely Ensure equipment is durable		6033
5.3003.21f Pressure drop: coil	Pressure drop across cooling coils will be in accordance with manufacturer specifications	Ensure equipment operates as designed Ensure equipment operates efficiently Ensure equipment provides comfort Ensure equipment operates safely Ensure equipment is durable		6034
5.3003.21g Pressure drop: filter	Pressure drop across filter will be in accordance with manufacturer specifications	Ensure equipment operates as designed Ensure equipment operates efficiently Ensure equipment provides comfort Ensure equipment operates safely Ensure equipment is durable		6035
5.3003.21h Balance of room flow: new ductwork	Airflow will be measured in accordance with ANSI/ACCA Standard 5 or ANSI/ASHRAE Standard 111 and adjusted to meet design requirements Examples of acceptable methods include the following: • Air flow will be measured at each register and compared to load calculation to ensure proper air flow delivery • Adjustments will be made to fan speed, dampers, and registers until design specifications are met	Ensure equipment operates as designed Ensure equipment operates efficiently Ensure equipment provides comfort Ensure equipment operates safely Ensure equipment is durable		6036
5.3003.21i Supply wet bulb and dry bulb	Supply wet bulb and dry bulb air temperatures will be recorded	Ensure equipment operates as designed Ensure equipment operates efficiently Ensure equipment provides comfort Ensure equipment operates safely Ensure equipment is durable		6037

5.3003.21j Return wet bulb and dry bulb	Return wet bulb and dry bulb air temperatures will be recorded	Ensure equipment operates as designed Ensure equipment operates efficiently Ensure equipment provides comfort Ensure equipment operates safely Ensure equipment is durable		6038
5.3003.21k Temperature rise: gas and oil furnaces only	Temperature rise between the supply and return will be in accordance with manufacturer specifications	Ensure equipment operates as designed Ensure equipment operates efficiently Ensure equipment provides comfort Ensure equipment operates safely Ensure equipment is durable		6039
5.3003.21l Final balance	Final air flow and/or pressure will be measured, confirmed, and recorded at air handler and registers Airflow will be measured in accordance with ANSI/ACCA Standard 5 or ANSI/ASHRAE Standard 111 and adjusted to meet design requirements	Provide acceptable thermal comfort, energy efficiency, and indoor air quality		6040
5.3003.21m Occupant/property manager education	Occupant/property manager will be: • Instructed on proper operation and maintenance procedures • Educated on value and need for recommissioning requirements • Property manager will complete a 30-hour OSHA safety education course	Ensure continued operation of equipment at design performance levels		6041

5.3003.22 Combustion Analysis—Low Rise

Topic: Forced Air

Subtopic: System Assessment and Maintenance

Desired Outcome: Analysis on critical components and operations is completed to industry and manufacturer specifications

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3003.22a Testing	Measurement equipment will be selected so that design value will be	Ensure accurate measurements of combustion by-products		6042

equipment selection	within the accurate range of the measuring device Equipment will be capable of accurately measuring +/- 10% in general case Measurement equipment will be calibrated and field checked in accordance with manufacturer recommendations			
5.3003.22b Combustion analysis protocol	Combustion analysis will be performed in accordance with manufacturer specifications and ANSI/ACCA Standard 5	Ensure accurate measurements of combustion by-products		6043
5.3003.22c Oil system: nozzle size	Nozzle size/spray angle/spray pattern will be correct for design input and within equipment firing rate of the heating system manufacturer	Ensure equipment operates as designed Ensure equipment operates safely Ensure equipment operates efficiently Ensure equipment is durable		6044
5.3003.22d Natural gas/propane system: burner orifice(s) size	Burner orifice(s) size will be in accordance with manufacturer specification	Ensure equipment operates as designed Ensure equipment operates safely Ensure equipment operates efficiently Ensure equipment is durable		6045
5.3003.22e Combustion air adjustment	Combustion air setting will be in accordance with manufacturer's recommendations and modified based on combustion analysis testing	Ensure equipment operates as designed Ensure equipment operates safely Ensure equipment operates efficiently Ensure equipment is durable		6046
5.3003.22f Fuel pressure/gas pressure	Measurement will be verified in accordance with manufacturer specifications	Ensure equipment operates as designed Ensure equipment operates safely Ensure equipment operates efficiently Ensure equipment is durable		6047
5.3003.22g Oil system: smoke test (this test must be conducted before any combustion testing has started)	Smoke spot reading will be in accordance with burner manufacturer specifications If smoke spot test is higher than manufacturer specifications, a steady state efficiency test will not be performed until the unit has been cleaned and tuned	Ensure equipment operates as designed Ensure equipment operates safely Ensure equipment operates efficiently Ensure equipment is durable Ensure testing equipment is not damaged		6048
5.3003.22h Steady state	Once burner has run for five to ten minutes, perform a SSE test with a	Ensure equipment operates as designed		6049

efficiency (SSE)	properly calibrated combustion analyzer Measurement will be verified in accordance with manufacturer specifications	Ensure equipment operates safely Ensure equipment operates efficiently Ensure equipment is durable		
5.3003.22i Net stack temperature	Net stack temperature will be measured and verified in accordance with manufacturer specifications	Ensure equipment operates as designed Ensure equipment operates safely Ensure equipment operates efficiently Ensure equipment is durable		6050
5.3003.22j Carbon dioxide and oxygen	Measurement will be verified in accordance with industry manuals (e.g., Testo, Bacharach) and manufacturer specifications	Ensure equipment operates as designed Ensure equipment operates safely Ensure equipment operates efficiently Ensure equipment is durable		6051
5.3003.22k Excess air	Excess air will be calculated and shown in accordance with industry manuals (e.g., Testo, Bacharach) and manufacturer specifications	Ensure equipment operates as designed Ensure equipment operates safely Ensure equipment operates efficiently Ensure equipment is durable		6052
5.3003.22l Carbon monoxide (CO) in flue gas	CO in the undiluted flue gas will be less than level specified in the applicable subsection of ANSI Z21	Ensure equipment operates as designed Ensure equipment operates safely Ensure equipment operates efficiently Ensure equipment is durable		6053

5.3003.23 Refrigerant Charge Evaluation—Low Rise

Topic: Forced Air

Subtopic: System Assessment and Maintenance

Desired Outcome: The refrigerant charge is correct

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

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3003.23a Verify	The equipment must be installed in accordance with written specifications and manufacturer specifications Proper airflows and/or water flows through the heat exchanger will be within manufacturer specifications	Ensuring accuracy of the evaluation		6054

	before refrigerant evaluation can be performed The system will be within the manufacturer permissible temperature tolerances and in steady state condition before refrigerant evaluation can be performed			
5.3003.23b Testing equipment	Measurement equipment will be calibrated and field checked in accordance with manufacturer recommendations Measurement equipment will be selected so that design value (pressure and temperature) will be within the accurate range of the measuring device	Ensure accurate measurements of refrigerant charge		6055
5.3003.23c Testing procedure	Refrigerant charge will be verified in accordance with ANSI/ACCA Standard 5 Examples of acceptable methods include the following: • Superheat test done under outdoor ambient temperatures specified by the manufacturer. Superheat value must be within +/- 5°F of the manufacturer-specified superheat value (or within manufacturer-recommended tolerances) • Subcooling test done under outdoor ambient temperatures specified by the manufacturer. Subcooling value must be within +/- 3°F of the manufacturer-specified subcooling value (or within manufacturer-recommended tolerances) • Any method approved and specifically documented by the manufacturer that will ensure proper refrigerant charge All work will be done by a licensed professional or qualified person	Ensure accurate measurements of refrigerant charge		6056
5.3003.23d Documentation	Documentation will be done in accordance with ANSI/ACCA Standard 5	Provide documentation for optimal operation and maintenance of equipment		6057

	Documented field data (including, but not limited to, operating refrigerant pressures, superheat and subcooling values, etc.), and operating conditions will be recorded at time of testing			

5.3003.24 Evaporative Cooler Maintenance and Repairs—Low Rise

Topic: Forced Air

Subtopic: System Assessment and Maintenance

Desired Outcome: Evaporative cooler evaluated and maintained as needed

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3003.24a Assessment and diagnosis	The following system elements will be assessed: • Pump • Pan • Spider • Float • Damper • Roof jack, roof support • Water line • Water valve • Electrical • Pads • Motor • Fan Elements will be repaired or replaced as needed	Ensure equipment operates as designed Ensure equipment operates safely Ensure equipment operates efficiently Ensure equipment is durable		6058
5.3003.24b Repair and maintenance	Calcium deposits will be removed Pads will be replaced Any additional repairs or replacements will be made as necessary System will be drained at the end of the cooling season	Ensure evaporative cooler functions properly Ensure system is durable Prevent freezing		6059
5.3003.24c Occupant education	A regular service schedule will be recommended to occupant Issues regarding multiple systems running will be discussed with occupant	Ensure occupant understands basic operation and importance of regular maintenance		6060

5.3003.25 Refrigerant Line Inspection—Mid and High Rise

Topic: Forced Air

Subtopic: System Assessment and Maintenance

Desired Outcome: Refrigerant lines properly installed

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3003.25a Insulation	All refrigerant lines will be insulated based on the equipment manufacturer's requirements All insulation will be properly sealed	Optimize operation of equipment		6061
5.3003.25b Ultraviolet (UV) protection of insulation	If exposed to sunlight, refrigerant line insulation will be protected from UV degradation (e.g., jacket)	Install insulation so it does not degrade		6062
5.3003.25c Sizing	Refrigerant lines will be sized in accordance with manufacturer specifications for the installed equipment	Ensure system moves appropriate volume of refrigerant		6063
5.3003.25d Installation quality	Refrigerant lines will be installed without kinks, crimps, excessive bends, or length Refrigerant lines will be joined together using manufacturer-approved method(s) Proper filter dryer(s) will be installed Refrigerant lines will be checked for leaks following EPA Section 608 and verified as leak free before refrigerant charging Proper evacuation and dehydration techniques will be employed before refrigerant charging	Ensure system moves appropriate volume of refrigerant Ensure containments do not harm the system Ensure the system is durable		6064
5.3003.25e Support	Refrigerant lines will be routed, supported, and secured to building 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		6065

5.3003.26 Electrical Service—Mid and High Rise

Topic: Forced Air

Subtopic: System Assessment and Maintenance

Desired Outcome: Electrical components properly tested by licensed or certified individual

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)

5.3003.26a Polarity	Polarity of equipment will be correct	Ensure equipment operates as designed Ensure equipment operates safely		6066
5.3003.26b Incoming power	Voltage, phase, and frequency will be in accordance with manufacturer specifications	Ensure equipment operates as designed		6067
5.3003.26c Wire size	Wire size will be appropriate for the equipment installed	Ensure equipment operates as designed Ensure equipment operates safely		6068
5.3003.26d Service disconnect	The proper service disconnect will be installed, and if fused, the proper fuses will be installed	Ensure equipment operates as designed Ensure equipment operates safely		6069
5.3003.26e Contactors, relays, and other electrical components	Voltage drop will be within acceptable range in accordance with manufacturer specifications	Ensure contractors, relays, and other electrical components do not overheat Ensure equipment operates as designed		6070
5.3003.26f Grounding	Adequate grounding will be present	Ensure equipment operates as designed Ensure equipment operates safely		6071
5.3003.26g Blower amperage	Amperage will be within original equipment manufacturer (OEM) specifications and/or code requirements	Ensure equipment operates as designed Ensure equipment operates efficiently Ensure equipment operates safely		6072
5.3003.26h Compressor amperage	Amperage will be within OEM specifications and/or code requirements	Ensure equipment operates as designed Ensure equipment operates efficiently Ensure equipment operates safely		6073
5.3003.26i Door switch operation	Blower compartment safety switch operation will be verified	Ensure blower does not operate during service		6074
5.3003.26j Electric strip heat	Amperage will be within OEM specifications and/or code requirements (NFPA 70 A and E)	Ensure equipment operates as designed Ensure equipment operates efficiently Ensure equipment operates safely		6075
5.3003.26k Heat pump: emergency heat	Emergency heat circuit functions will be verified Amperage will be within OEM specifications and/or code requirements (NFPA 70 A and E)	Ensure system delivers heat in case of compressor failure Ensure equipment operates as designed Ensure equipment operates safely		6076

5.3003.27 Air Flow—Mid and High Rise

Topic: Forced Air

Subtopic: System Assessment and Maintenance

Desired Outcome: Air flow is properly tested

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3003.27a Validate installation of air distribution system	System will be checked for existence of specified system components	Confirm installed system Familiarize building operations staff and property manager with system components Verify system readiness for testing		6077
5.3003.27b Testing equipment selection	Measurement equipment will be selected so that design value will be within the accurate range of the measuring device Equipment will be capable of accurately measuring +/- 10% in general case Measurement equipment will be calibrated and field checked in accordance with manufacturer recommendations	Ensure accurate measurements of airflow rates		6078
5.3003.27c Test main fan or air handler	Equipment testing will check for: • Proper operation (schedule/sequence of operation) • Proper rotation • Filter condition • Total flow at fan	Verify performance of air handler system		6079
5.3003.27d Measure air flow at terminals (commissioning)	Airflow will be measured in accordance with ANSI/ACCA Standard 5 or ANSI/ASHRAE Standard 111 and adjusted to meet the design requirements Testing/validation will be performed by certified test and balance technicians (certified by NEBB and/or AABC or equivalent)	Verify distribution system Identify potential adjustments Establish baseline air flow rates		6080
5.3003.27e Supply wet bulb and dry bulb	Supply wet bulb and dry bulb air temperatures will be recorded	Ensure equipment operates as designed Ensure equipment operates efficiently Ensure equipment provides comfort Ensure equipment operates safely		6081
5.3003.27f Return wet bulb and dry bulb	Return wet bulb and dry bulb air temperatures will be recorded	Ensure equipment operates as designed Ensure equipment operates efficiently Ensure equipment provides comfort		6082

		Ensure equipment operates safely		
5.3003.27g Thermostat wet bulb and dry bulb	Thermostat wet bulb and dry bulb air temperatures will be recorded	Ensure equipment operates as designed Ensure equipment operates efficiently Ensure equipment provides comfort		6083
5.3003.27h System adjustment	Airflow will be measured in accordance with ANSI/ACCA Standard 5 or ANSI/ASHRAE Standard 111 and adjusted to meet the design requirements Adjustments will be made to: • Fan speed (via sheave adjustment, replacement, and/or variable frequency drive motor replacement) • Dampers • Registers	Balance the system utilizing least resistance and energy		6084
5.3003.27i Final balance	Final air flow and/or pressure will be measured and confirmed at air handler and registers Airflow will be measured in accordance with ANSI/ACCA Standard 5 or ANSI/ASHRAE Standard 111 and adjusted to meet the design requirements	Provide acceptable thermal comfort, energy efficiency, and indoor air quality		6085
5.3003.27j Education	Occupant/property manager will be: • Educated on proper operation and maintenance procedures • Educated on value and need for recommissioning requirements Property manager will be educated with a 30-hour OSHA safety education course	Ensure equipment continues to operate at the design performance levels		6086

5.3003.28 Compressor—Mid and High Rise

Topic: Forced Air

Subtopic: System Assessment and Maintenance

Desired Outcome: Compressor operates as designed

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3003.28a Sizing	Compressor will be properly sized for the existing equipment and evaluated	Ensure equipment operates as designed		6087

	in accordance with ANSI/ACCA Standard 5	Ensure equipment operates safely Ensure equipment operates efficiently Ensure equipment is durable		
5.3003.28b Location	Compressor will be located in an area that is on a level surface and that provides adequate ventilation	Ensure equipment operates as designed Ensure proper lubrication of moving parts Ensure equipment operates efficiently Ensure equipment is durable		6088
5.3003.28c Refrigerant piping	Suction line will be properly sized Refrigeration tubing will be used Inert gas will be trickled through piping when brazing joints together Filter dryer will be installed P-type oil traps will be located at the base of suction line riser Proper evacuation and dehydration procedures will be followed Horizontal runs will be sloped 1" per 20' toward the compressor Vibration absorbers may be used and installed in accordance with manufacturer specifications	Ensure adequate velocities for proper oil return Ensure that the piping is installed in a manner that does not interfere with normal maintenance or service procedures Ensure contaminants do not enter the system Ensure proper operation Ensure equipment operates efficiently Ensure equipment is durable		6089
5.3003.28d Electrical	Field wiring will be installed in accordance with NFPA 70 National Electric Code and local codes Proper voltage, frequency, and phase will coincide with the nameplate	Ensure equipment operates as designed Ensure equipment operates safely Ensure equipment operates efficiently Ensure equipment is durable		6090
5.3003.28e Startup	All electrical connections will be tight All safety controls will be installed and operational Oil level will meet manufacturer-recommended level Only approved refrigerant oil will be used Proper refrigerant charge will be verified by approved methods Refrigerant type and amount will be documented	Ensure equipment operates as designed Ensure equipment operates safely Ensure equipment operates efficiently Ensure equipment is durable		6091
5.3003.28f Maintenance	Maintenance will be scheduled in accordance with ANSI/ACCA/ASHRAE Standard 180; Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems or ANSI/ACCA Standard 4	Ensure equipment operates as designed Ensure equipment operates safely Ensure equipment operates efficiently Ensure equipment is durable		6092

	Maintenance of Residential HVAC Systems Maintenance procedures include, but are not limited to, the following: • Refrigerant charge will be evaluated, and refrigerant will be added or removed as necessary (a lack of refrigerant may indicate a leak, which will need to be corrected) • Oil level will be evaluated, and oil will be added or removed as necessary • Filter dryer moisture indicator and pressure drop across the filter will be evaluated • Filter dryer will be replaced as necessary • Amperage draw will be evaluated and compared to the compressor nameplate			

5.3003.29 Thermostatic Expansion Valve—Mid and High Rise

Topic: Forced Air

Subtopic: System Assessment and Maintenance

Desired Outcome: Ensure thermostatic expansion valve (TXV) operates as designed

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3003.29a Identify type	TXV valve will be identified as either: • Mechanical device • Internal equalized • External equalized • Electronic device	Understand device function and manufacturer requirements for operation		6093
5.3003.29b Cooling system operation	TXV proper size and operation will be verified	Understand device function and manufacturer requirements for operation Obtain most efficient operation		6094
5.3003.29c Replacement	Replacement will meet manufacturer specifications for the given model number of the unit	Ensure efficient operation of the unit		6095

5.3003.30 Refrigerant Charge Evaluation—Mid and High Rise

Topic: Forced Air

Subtopic: System Assessment and Maintenance

Desired Outcome: Correct refrigerant charge

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3003.30a Verify	Equipment must be installed in accordance with written and manufacturer specifications Proper air flows and/or water flows through the heat exchanger will be within manufacturer tolerances before refrigerant evaluation can be performed System will be within the manufacturer-permissible temperature tolerances and in steady state condition before refrigerant evaluation can be performed	Ensure accuracy of the evaluation		6096
5.3003.30b Testing equipment	Measurement equipment will be calibrated and field checked according to manufacturer specifications Measurement equipment will be selected so that design value (pressure and temperature) will be within the accurate range of the measuring device	Ensure accurate measurements of refrigerant charge		6097
5.3003.30c Testing procedure	Proper refrigerant charge will be evaluated and documented in accordance with ANSI/ACCA Standard 5 Examples of acceptable procedures that may be performed are: • Superheat test done under outdoor ambient temperatures specified by the manufacturer. Superheat value must be within +/- 5°F of the manufacturer-specified superheat value (or within manufacturer-recommended tolerances) • Subcooling test done under outdoor ambient temperatures specified by the manufacturer. Subcooling value must be within +/- 3°F of the manufacturer-specified	Ensure optimal operation of the equipment		6098

	subcooling value (or within manufacturer-recommended tolerances) • Any method approved and specifically documented by the manufacturer that will ensure proper refrigerant charge			
5.3003.30d Documentation	Documentation will be done in accordance with ANSI/ACCA Standard 5 Documented field data (including, but not limited to, operating refrigerant pressures, superheat and subcooling values, etc.), and operating conditions will be recorded at time of testing	Provide documentation for optimal operation and maintenance of equipment		6099

5.3003.31 Cooling Tower—Mid and High Rise

Topic: Forced Air

Subtopic: System Assessment and Maintenance

Desired Outcome: Cooling tower evaluated and maintained as needed

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3003.31a Submetering	Submeters will be installed on the supply and bleed lines of the cooling tower Submeters installed on the bleed line will be suitable to deal with solids	Ensure efficient system operation Reduce water consumption		6100
5.3003.31b Water treatment	Cooling tower water will be treated to prevent buildup of scale and algae	Ensure system durability Ensure system operates efficiently		6101

5.3003.32 Evaporative Cooler Maintenance and Repairs—Mid and High Rise

Topic: Forced Air

Subtopic: System Assessment and Maintenance

Desired Outcome: Evaporative cooler evaluated and maintained as needed

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3003.32a Assessment	The following system elements will be assessed:	Ensure all components function properly		6102

and diagnosis	• Pump • Pan • Spider • Float • Damper • Roof jack, support • Water line • Water valve • Electrical • Pads • Motor • Fan Elements will be repaired or replaced as needed	Ensure equipment operates safely Ensure equipment operates efficiently Ensure equipment is durable		
5.3003.32b Repair and maintenance	Calcium deposits will be removed Pads will be replaced Any additional repairs or replacements will be made as necessary Water treatment will be regularly tested and maintained Equipment will operate in accordance with local codes and standards Equipment will be drained at the end of the cooling season	Ensure evaporative cooler functions properly Ensure equipment operates at maximum efficiency Ensure equipment durability Ensure system does not freeze during the winter months		6103
5.3003.32c Building staff education	Maintenance will be scheduled in accordance with ANSI/ACCA/ASHRAE Standard 180;Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems or ANSI/ACCA Standard 4 Maintenance of Residential HVAC Systems A regular service schedule will be recommended to building staff	Ensure building staff understand basic operation and the importance of routine maintenance		6104

5.3003.33 Fuel Delivery System for Fuel Oil—Low Rise

Topic: Forced Air

Subtopic: System Assessment and Maintenance

Desired Outcome: Fuel oil delivered safely and sufficiently

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

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		

5.3003.33a Material and support	An approved pipe type in accordance with NFPA will be installed and supported The presence of the fire valve, manual oil shut off valve, union joint, and filter fitting will be verified or installed All work will be done by a licensed professional or qualified person	Prevent corrosion Deliver fuel to the system Ensure material does not sag or leak		6105
5.3003.33b Line connections	Approved connectors for line fittings will be used Approved filter fittings will be used All lines will be tested for leaks All work will be done by a licensed professional or qualified person	Install oil lines and ensure there are no leaks		6106
5.3003.33c Filter	Oil filter insert and pump strainer will be replaced or a new filter will be installed whenever an oil system is serviced or replaced All work will be done by a licensed professional or qualified person	Ensure oil is free of debris		6107

5.3003.34 Fuel Delivery System for Natural Gas and Propane—Low Rise

Topic: Forced Air

Subtopic: System Assessment and Maintenance

Desired Outcome: Natural gas and propane delivered safely and in sufficient amounts

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

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3003.34a Material and support	An approved pipe type in accordance with NFPA will be installed and supported Manual gas shut off valve, union joint, and drip leg will be verified or installed All work will be done by a licensed professional or qualified person	Prevent corrosion Deliver fuel to the system Ensure material does not sag or leak		6108
5.3003.34b Size	Gas pipes (building main and equipment drops) will be installed for the total connected load of all appliances in accordance with NFPA All work will be done by a licensed professional or qualified person	Provide sufficient gas flow and pressure to all of the appliances		6109

5.3003.34c Sealant	Pipes will be sealed with an approved fastening process and sealant in accordance with manufacturer specifications Gas lines will be leak free when tested with an electronic combustible gas leak detector and verified with bubble solution Gas lines will be leak free when tested by local code-approved standing pressure test All work will be done by a licensed professional, or qualified person	Install gas lines with no leaks		6110
5.3003.34d Safety devices for propane	A secondary gas valve safety detector will be installed for propane piping installed below grade All work will be done by a licensed professional or qualified person	Detect accumulation of dangerous levels of propane in areas that are below grade		6111

5.3003.35 Combustion Appliance Venting System—Low Rise

Topic: Forced Air

Subtopic: System Assessment and Maintenance

Desired Outcome: Combustion products are properly vented to the outdoors

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3003.35a Combustion air	Combustion supply/exhaust air opening will be in compliance with applicable NFPA standards or local code	Exhaust combustion products to the outdoors Ensure work does not damage building Protect workers and occupants from injury		6112
5.3003.35b Flue vent material	Flue vent material will be selected to prevent flue gas freezing and/or corrosion (using double wall, where necessary) Cost-effective materials will be used when appropriate and allowable	Ensure durability of flue vent system Ensure selected material is appropriate and cost-effective		6113
5.3003.35c Installation	Venting systems will be installed considering proper material, pitch, common venting, chimney liner, clearance, total equivalent length, and termination in accordance with NFPA 54, 31, 211 Category I venting systems will be installed in accordance with NFPA 54/ANSI Z223.1	Exhaust combustion products to the outdoors Ensure work does not damage building Protect workers and occupants from injury		6114

	Category III and IV venting systems will be installed in accordance with the manufacturer specifications Terminations will be located away from windows, doors, and walkways Aesthetics and noise will be considered Venting will be routed in the shortest and most direct path possible Vent joints will be airtight and watertight			
5.3003.35d Orphaned equipment	Existing vent system or chimney will be resized or relined in accordance with the applicable NFPA standard when one or more common vented appliances are removed	Exhaust combustion products to the outdoors Ensure work does not damage building Protect workers and occupants from injury		6115

5.3003.36 Ductwork System—Low Rise

Topic: Forced Air

Subtopic: System Assessment and Maintenance

Desired Outcome: The duct system safely supports peak operation of the equipment

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

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3003.36a Location: indoor (supply ducts) duct section located completely within the thermal boundary of the building	Duct material will be installed with an R-value compliant with code An appropriate vapor retarder will be installed	Prevent condensation on the outside of the ductwork		6116
5.3003.36b Location: outdoors duct section located outside of the thermal boundary of the building or in quasi-	Duct material will be selected that meets the following criteria: • An insulation level compliant with code • Permeability that prevents condensation • Permeability that reduces heat loss or gain from the ductwork	Prevent condensation on the outside of the ductwork Reduce thermal loss or gain from the ductwork		6117

conditioned spaces				
5.3003.36c Building cavities used as ductwork	When viable building cavities used as ductwork will be replaced with properly sized conventional duct material When replacement is not an option, building cavities used as ductwork will be sealed when accessible	Safeguard indoor environmental quality Maximize airflow Minimize energy use		6118
5.3003.36d Fire rating	Ducts will be installed in accordance with the fire rating of local codes	Prevent a fire hazard		6119
5.3003.36e Penetrations	Interior wall penetrations for ductwork will be sealed with a durable sealant (e.g., caulk, silicone, foam) Penetrations through fire walls and floors will be sealed with a fire-rated material	Prevent a fire hazard		6120
5.3003.36f Support	Ductwork will be supported in a manner that does not constrict ductwork or duct insulation per SMACNA duct construction standards (ADC for flexible duct or NAIMA for fiberglass duct)	Ensure ducts do not sag, bend, trap water, or experience diminished air flow		6121
5.3003.36g Protection	Ducts will be routed such that service and repair to the building and its systems does not damage the ducts	Protect equipment from damage Ensure equipment operates as designed		6122
5.3003.36h Fastening: metal to flexible duct	Flexible duct-to-metal connections will be fastened with tie bands using a tie band tensioning tool Beaded collars will be installed for all sheet metal to flexible duct connections Mastic will be applied to interior flex lining to metal connection Manufacturer specifications will be followed	Ensure duct connections are durable		6123
5.3003.36i Fastening: metal to metal	Metal-to-metal connections will be fastened with equally spaced mechanical fasteners Gaps larger than 1/4" will be bridged with sheet metal Joints will be sealed with mastic Joints smaller than 1/4" will be sealed with NFPA 90A and B approved sealant	Ensure duct connections are durable		6124
5.3003.36j Fastening: duct board to metal	Duct board to metal connections will be fastened with mechanical fasteners	Ensure duct connections are durable		6125

	Joints and connections will be sealed with UL 181A listed tapes or mastics			
5.3003.36k Fastening: boot to building connection	Boots will be fastened to the building with mechanical fasteners Connection will be sealed with mastic, caulk, or gaskets	Ensure duct connections are durable Properly seal the boots to minimize air leakage		6126
5.3003.36l Terminations	Terminations capable of delivering air with proper speed and throw of 80-120% of the farthest wall, floor, or ceiling will be selected Selections will be based on ANSI/ACCA Manual T Air Distribution Basics	Deliver and properly mix air in the building		6127
5.3003.36m Filtration	Filter bypasses will be eliminated Airtight filter slot covers will be installed to prevent return air leakage in combustion appliance zone Filters will be changed Filters with high static pressure drops will be avoided A visual inspection for excessive dust and debris will be performed, and ducts will be cleaned accordingly	Protect equipment from dirt and debris Allow for proper airflow		6128
5.3003.36n External static pressure	Ductwork, filter, and other equipment will be installed so total external static pressure does not exceed manufacturer specifications	Ensure equipment operates as designed		6129
5.3003.36o Air flow: cooling and heat pump systems	Measured air flow per ton will meet manufacturer specifications Airflow will be established in accordance with ANSI/ACCA 5 QI HVAC Quality Installation Specification and ASHRAE Standards	Ensure equipment operates as designed		6130
5.3003.36p Temperature rise: heating-only systems	Temperature rise will be measured, and the result will be in accordance with manufacturer specifications	Ensure equipment operates as designed		6131
5.3003.36q System protection during construction and renovation	Registers, grilles, and diffusers will be blocked, masked, or otherwise sealed with a durable material Use of system will not be allowed during renovation or construction Contractor and occupant will be educated on necessity of protecting the equipment	Protect equipment and occupants from debris in the system		6132
5.3003.36r Room	An appropriate means of pressure balancing will be installed (e.g.,	Ensure system has unrestricted airflow between supplies and returns		6133

pressure balancing	transfer grilles, jumper ducts, individual room returns) Room-to-room pressure differences shall not exceed +/- 3 pascals with the air handler running	Minimize infiltration and exfiltration caused by system Prevent interference with safe operation of combustion appliances		
5.3003.36s Sealing: new ductwork	Total system leakage (including air handler) will not exceed 20% of designed system airflow (cubic feet per minute) when tested at 25 pascals For partial duct system replacement or improvement, existing ductwork specification will be applied	Minimize system air leakage		6134
5.3003.36t Sealing: existing ductwork	Accessible joints, cracks, seams, holes, and penetrations will be sealed	Minimize system air leakage		6135

5.3003.37 Heating and Cooling Controls—Low Rise

Topic: Forced Air

Subtopic: System Assessment and Maintenance

Desired Outcome: Heating and cooling controls installed and set properly

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3003.37a Removal of mercury-based thermostats	Mercury-based thermostats will be removed safely and disposed of in accordance with EPA regulations	Protect workers and occupants from injury Protect the environment from damage		6136
5.3003.37b 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		6137
5.3003.37c Penetrations	Penetrations for control wiring will be sealed with a durable sealant (e.g., caulk, silicone, foam) Penetrations through fire walls will be sealed with a fire-rated material	Ensure controls operate as designed Minimize infiltration and exfiltration from building Prevent pest infestation		6138
5.3003.37d Thermostat location	Thermostats will be installed to reflect the temperature of the zone in which they are installed Thermostats will not be exposed to extreme temperatures, radiant heat sources, warm/cold walls, and drafts	Ensure controls operate as designed		6139
5.3003.37e Blower speed	Total airflow will be measured in accordance with ANSI/ACCA Standard 5 or ANSI/ASHRAE	Ensure the equipment has correct air flow		6140

	Standard 111 and adjusted to meet design requirements			
5.3003.37f Thermostat selection: heat pump	A thermostat with equipment supplementary heat lockout that can interface with an outdoor temperature sensor will be selected	Maximize the heating output of the compressor (heat pump mode eliminates supplementary heat) to achieve energy efficiency		6141
5.3003.37g Heat pump: supplementary heat	Thermal and economic balance point will be calculated and an optimum thermal balance point will be selected in accordance with ANSI/ACCA Manual S The design of variable refrigerant flow systems are permitted to not require supplementary heat	Maximize the heating output Maximize the heating output of the compressor (heat pump mode eliminates supplementary heat) to achieve energy efficiency		6142
5.3003.37h Heat pump: outdoor temperature sensor	An outdoor temperature sensor will be installed in accordance with manufacturer specifications	Ensure equipment operates as designed		6143
5.3003.37i Heat pump: supplementary heat control wiring	Supplementary heat will be wired onto second stage heating terminal (W2)	Do not operate supplementary heat in stage one heating		6144
5.3003.37j 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		6145
5.3003.37k 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 the transfer of the heat without adversely affecting indoor humidity levels		6146
5.3003.37l Humidistat: location	Humidistat will be installed to accurately reflect humidity of the zone in which it is installed	Ensure controls operate as designed		6147
5.3003.37m Occupant education	Occupants will be educated on proper use of thermostat, including: • Proper use of setbacks for air conditioners and heat pumps • Allowing occupant comfort to determine setback for combustion-heating appliances • Using emergency heat appropriately	Ensure equipment and controls operate as designed Provide comfort throughout building		6148
5.3003.37n Central controller	Wiring and sensors will be installed in accordance with manufacturer specifications	Educate building manager to monitor and control the entire building		6149

5.3003.38 Condensate Drainage of Heating and Air Conditioning Equipment—Low Rise

Topic: Forced Air

Subtopic: System Assessment and Maintenance

Desired Outcome: Equipment and condensate drain operate as designed

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3003.38a Connection	Connections in condensate drain system will be watertight	Ensure condensate drain connection does not leak		6150
5.3003.38b Insulation	Condensate drain lines will be insulated with a minimum 1" of insulation with a vapor retarder when there is potential for condensation or freezing on the drain line	Ensure condensate drain connections do not leak		6151
5.3003.38c Overflow protection: up flow	Secondary drain pan and float switch will be installed when overflow could damage finished surfaces or up flow systems will have a float switch installed in the primary condensate drain when overflow could damage finished surfaces Float switch will be interlocked with the cooling circuit and will break the circuit when a leak occurs	Ensure condensate drain connections do not leak		6152
5.3003.38d Pumps	Condensate drain pumps will be installed when condensate cannot be drained by gravity Power source for pumps will be installed Operation and drainage of pump will be verified	Ensure condensate drain connections do not leak		6153
5.3003.38e Vents and traps	Vents and traps will be installed on condensate drain lines, including condensing heating systems in accordance with manufacturer specifications For combustion-heating equipment, trap supplied with the equipment will be used in accordance with manufacturer specifications	Ensure condensate drain operates as designed Ensure condensate drain does not leak		6154
5.3003.38f Drain pan	A secondary drain pan will be installed for all air conditioning, air handler, or evaporator coil installations where water damage may occur The secondary pan will contain a drain, which will be ran separately	Prevent water damage from a malfunctioning drain system To alert building owner or maintenance staff that a problem exists		6155

	from the primary condensate drain to a visible termination point The secondary drain pan will be pitched toward the drain line to ensure that moisture is removed from the building			
5.3003.38g Water level detection device	All secondary drain pans will have a water level detection device interlocked with the cooling control circuit that shuts down the unit when a leak occurs	Prevent water from overflowing the pan and draining onto the ceiling below		6156
5.3003.38h Termination	Condensate drain will be terminated in accordance with local codes	Ensure condensate does not leak into the building Ensure condensate drain does not freeze		6157

5.3003.39 Fuel Delivery System for Natural Gas—Mid and High Rise

Topic: Forced Air

Subtopic: System Assessment and Maintenance

Desired Outcome: Safe and optimal gas supply to all gas-fired equipment

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

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3003.39a Location, material, and support	An approved pipe type in accordance with NFPA 54/ANSI/AGA Z223.1 will be installed and supported Gas train will be located/installed to not create a trip hazard or be damaged by water All work will be done by a licensed professional or qualified person	Ensure worker safety Ensure durability of equipment		6158
5.3003.39b Size	Gas pipes (building main and equipment drops) will be installed for the total connected load of all appliances in accordance with NFPA 54/ANSI/AGA Z223.1 Existing gas piping will provide appropriate pressure and supply rate for heating equipment in accordance with scope of work All work will be done by a licensed professional or qualified person	Ensure safe and proper gas supply to equipment		6159

5.3003.39c Installation	Pipe routing will create the least pressure drop Gas pressure regulators requiring venting will be vented to outside the building with a rigid pipe Gas train components, pipe material, and pipe sizing will comply with all applicable codes and standards (AGA, NFPA) Pipes will be sealed with an approved fastening process and sealant in accordance with manufacturer specifications All work will be completed by a licensed professional or qualified person	Deliver adequate gas pressure to heating equipment Ensure worker safety Install gas lines with no leaks		6160
5.3003.39d Testing	For newly installed systems, gas train will be pressure tested for leaks For existing systems, gas train will be tested for leaks in accordance with local utility requirements Gas pressure and supply rates will be tested to confirm they comply to specified scope of work and burner requirements All work will be supervised by a licensed professional or qualified person	Ensure safe operating conditions		6161
5.3003.39e Education	Property manager will be educated on the operation of the high and low gas pressure switches, gas valve, and gas regulator Property manager will be educated on the indications of raw gas leaks	Ensure property manager and occupant safety Maintain proper operation of gas train		6162

5.3003.40 Fuel Delivery System for Fuel Oil—Mid and High Rise

Topic: Forced Air

Subtopic: System Assessment and Maintenance

Desired Outcome: Fuel oil is delivered safely and sufficiently

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

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)	

5.3003.40a Material and support	An approved pipe type in accordance with NFPA 31 will be installed and supported Manual oil shut off valve, union joint, and filter fitting will be installed or presence verified	Prevent corrosion Deliver fuel to system Ensure material does not sag or leak		6163
5.3003.40b Line connections	Approved connectors for line fittings will be used Approved filter fittings will be used All lines will be tested for leaks All work will be done by a licensed professional or qualified person	Install oil lines and ensure there are no leaks		6164
5.3003.40c Filter	Oil filter insert will be replaced or a new filter installed whenever an oil system is serviced or replaced	Ensure oil is free of debris		6165
5.3003.40d Pumps	Installation of a pump will be verified with the existing/proposed equipment The pump will be designed to manufacturer specifications based on fuel type, distance from tank, equipment size Strainer will be installed in the supply of the pump	Provide adequate supply of fuel to the equipment Ensure equipment durability		6166

5.3003.41 Combustion Appliance Venting System—Mid and High Rise

Topic: Forced Air

Subtopic: System Assessment and Maintenance

Desired Outcome: Combustion products properly vented to the outdoors

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3003.41a Combustion air	Combustion supply/exhaust air opening will be in compliance with applicable NFPA standard (NFPA 31 or NFPA 54/ANSI/AGA Z223.1) or applicable local code	Exhaust combustion products to the outdoors Ensure building is not damaged Protect workers and occupants from injury		6167
5.3003.41b Flue vent material selection	Flue vent material will be selected to prevent flue gas freezing and/or corrosion (using double wall where necessary) Cost-effective materials will be used when appropriate and allowable	Ensure durability of flue vent system Ensure selected material is appropriate and cost-effective		6168
5.3003.41c Installation	Venting systems will be installed considering proper material, pitch, common venting, chimney liner,	Exhaust combustion products to the outdoors Ensure building is not damaged		6169

	clearance, total equivalent length, and termination in accordance with applicable code Category I venting systems will be installed in accordance with applicable code Category III and IV venting systems will be installed in accordance with manufacturer specifications Termination will be located away from windows, doors, and walkways Aesthetics and noise will be considered Venting will be routed in the shortest and most direct path possible Joints in the flue piping will be properly sealed to prevent flue gas and condensation leakage	Protect workers and occupants from injury		

5.3003.42 Ductwork System—Mid and High Rise

Topic: Forced Air

Subtopic: System Assessment and Maintenance

Desired Outcome: The ductwork system safely supports peak operation of equipment

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3003.42a Location: indoor (supply ducts) duct section located completely within the thermal boundary of the building	Duct material will be installed with an R-value compliant with code An appropriate vapor retarder will be installed	Prevent condensation on the outside of the ductwork		6170
5.3003.42b Location: outdoors duct section located outside of the thermal boundary of the building	Duct material will be selected that meets the following criteria: • An insulation level compliant with code • Permeability that prevents condensation • Permeability that reduces heat loss or gain from the ductwork	Prevent condensation on the outside of the ductwork Reduce thermal loss or gain from the ductwork		6171

or in quasi-conditioned spaces				
5.3003.42c Location: exterior duct is exposed to the elements	Duct material will be selected that meets the following criteria: • An insulation level compliant with code • A weatherproof barrier that is resistant to ultraviolet light damage	Prevent condensation on the outside of the ductwork Reduce thermal loss or gain from the ductwork Protect ductwork from elements		6172
5.3003.42d Fire rating	Ducts will be installed in accordance with the fire rating of local codes	Prevent a fire hazard		6173
5.3003.42e Support	Ductwork will be supported in a manner that does not constrict ductwork or duct insulation per SMACNA duct construction standards, ADC for flexible ducts, or NAIMA for fiberglass ducts	Ensure ducts do not sag, bend, trap water, or experience diminished air flow		6174
5.3003.42f Protection	Ducts will be routed such that service and repair to the building and its systems does not damage the ducts	Protect equipment from damage Ensure equipment operates as designed		6175
5.3003.42g Fastening metal to flexible duct	Flexible duct-to-metal connections will be fastened with tie bands using a tie band tensioning tool Beaded collars will be installed for all sheet metal to flexible duct connections Mastic will be applied to interior flex lining to metal connection Manufacturer specifications will be followed	Ensure duct connections are durable		6176
5.3003.42h Fastening metal to metal	Metal-to-metal connections will be fastened with mechanical fasteners Gaps larger than 1/4" will be bridged with sheet metal Joints will be sealed with mastic Joints smaller than 1/4" will be sealed with NFPA 90A and B approved sealant	Ensure duct connections are durable		6177
5.3003.42i Fastening duct board to metal	Duct board to metal connections will be fastened with mechanical fasteners Joints and connections will be sealed with UL 181A listed tapes or mastics	Ensure connections are durable		6178
5.3003.42j Fastening boot to building connection	Boots will be fastened to the building with mechanical fasteners Connection will be sealed with mastic, caulk, or gaskets	Ensure duct connections are durable Properly seal boots to minimize air leakage		6179

5.3003.42k Terminations	Terminations capable of delivering air with proper speed and throw of 80-120% of the farthest wall, floor, or ceiling will be selected Terminations will have a noise criteria level less than 30 decibels	Deliver and properly mix air in the building Deliver air with acceptable noise levels		6180
5.3003.42l Filtration	Filter bypasses will be eliminated Filters will be changed	Protect equipment from dirt and debris		6181
5.3003.42m External static pressure	Ductwork, filter, and other equipment will be installed so that total external static pressure does not exceed manufacturer specifications	Ensure equipment operates as designed		6182
5.3003.42n Airflow: cooling and heat pump systems	Measured air flow per ton will meet manufacturer specifications Airflow will be established in accordance with ANSI/ACCA 5 QI HVAC Quality Installation Specification and ASHRAE standards	Ensure equipment operates as designed		6183
5.3003.42o Temperature rise: heating only systems	Temperature rise will be measured, and the result will be in accordance with manufacturer specifications	Ensure equipment operates as designed		6184
5.3003.42p System protection during construction and renovation	Registers, grilles, and diffusers will be blocked, masked, or otherwise sealed with a durable material Use of system will not be allowed during renovation or construction Contractor and occupant will be educated on necessity of protecting equipment	Protect equipment and occupants from debris in the system		6185
5.3003.42q Room pressure balancing	An appropriate means of pressure balancing will be installed (e.g., transfer grilles, jumper ducts, individual room returns) Room-to-room pressure differences shall not exceed +/- 3 pascals with the air handler running	Ensure system has unrestricted flow of air between supplies and returns Minimize infiltration and exfiltration caused by system Do not interfere with safe operation of combustion appliances		6186
5.3003.42r Sealing: new ductwork	Total system leakage (including air handler) will not exceed 20% of designed system airflow (cubic feet per minute) when tested at 25 pascals (For partial duct system replacement or improvement, existing ductwork specification will be applied)	Minimize system air leakage		6187
5.3003.42s Sealing: existing ductwork	Accessible joints, cracks, seams, holes, and penetrations will be sealed	Minimize system air leakage		6188

5.3003.43 Heating and Cooling Controls—Mid and High Rise

Topic: Forced Air

Subtopic: System Assessment and Maintenance

Desired Outcome: Heating and cooling controls installed and set properly

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3003.43a Removal of mercury-based thermostats	Mercury-based thermostats will be safely removed and disposed of in accordance with EPA regulations	Protect workers and occupants from injury Protect environment from damage		6189
5.3003.43b 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		6190
5.3003.43c Penetrations	Penetrations for control wiring will be sealed with a durable sealant (e.g., caulk, silicone, foam) Penetrations through fire walls will be sealed with a fire-rated material	Ensure controls operate as designed Minimize infiltration and exfiltration from building		6191
5.3003.43d Thermostat location	Thermostats will be installed to reflect the temperature of the zone in which they are installed Thermostats will not be exposed to extreme temperatures, radiant heat sources, and drafts	Ensure controls operate as designed		6192
5.3003.43e Blower speed	Total airflow will be measured in accordance with ANSI/ACCA Standard 5 or ANSI/ASHRAE Standard 111 and adjusted to meet design requirements	Ensure equipment has correct air flow		6193
5.3003.43f Thermostat selection: heat pump	A thermostat with equipment supplementary heat lockout that can interface with an outdoor temperature sensor will be selected	Maximize heating output of the compressor (heat pump mode eliminates supplementary heat) to achieve energy efficiency		6194
5.3003.43g Heat pump: supplementary heat	Thermal and economic balance point will be calculated and an optimum thermal balance point will be selected in accordance with ANSI/ACCA Manual S Variable refrigerant flow systems may be designed to not require supplementary heat	Maximize heating output of the compressor (heat pump mode eliminates supplementary heat) to achieve energy efficiency		6195
5.3003.43h Heat pump: outdoor	An outdoor temperature sensor will be installed in accordance with manufacturer specifications	Ensure equipment operates as designed		6196

temperature sensor change				
5.3003.43i Supplementary heat wiring of heat pump	Supplementary heat will be wired onto second stage heating terminal (W2)	Do not operate supplementary heat in stage one heating		6197
5.3003.43j 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		6198
5.3003.43k 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		6199
5.3003.43l Humidistat: location	Humidistat will be installed to reflect humidity of the zone in which it is installed	Ensure controls operate as designed		6200
5.3003.43m Occupant and building operations staff education	Occupants and building operations staff will be educated on proper use of thermostat, including: • Proper use of setbacks for air conditioners and heat pumps • Allowing occupant comfort to determine setback for combustion-heating appliances • Using emergency heat appropriately	Ensure equipment and controls operate as designed Provide comfort throughout building		6201
5.3003.43n Central controller	Wiring and sensors will be installed in accordance with manufacturer specifications	Enable building manager to monitor and control the entire building		6202

5.3088.2 Regional Climatic Considerations

Topic: Forced Air

Subtopic: Special Considerations

Desired Outcome: Regional climatic variables are taken into consideration

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3088.2a Very cold	Condensate line will be insulated Verification of proper charge will be conducted when outdoor temperatures are suitable Refrigerant charge evaluation will be done using proper evaluation techniques (subcooling/superheat)	Prevent freezing Ensure proper equipment operation		6203

	depending on metering device in accordance with ANSI/ACCA Standard 5 Refrigerant will be weighed into heating, ventilation, and air-conditioning (HVAC) systems when outdoor temperatures do not facilitate accurate testing of system charge			
5.3088.2b Cold	Condensate line will be insulated Verification of proper charge will be conducted when outdoor temperatures are suitable Refrigerant charge evaluation will be done using proper evaluation techniques (subcooling/superheat) depending on metering device in accordance with ANSI/ACCA Standard 5 Refrigerant will be weighed into HVAC systems when outdoor temperatures do not facilitate accurate testing of system charge	Prevent freezing Ensure proper equipment operation		6204
5.3088.2c Mixed humid	Refrigerant will be weighed into HVAC systems when outdoor temperatures do not facilitate accurate testing of system charge Verification of proper charge will be conducted when outdoor temperatures are suitable Refrigerant charge evaluation will be done using proper evaluation techniques (subcooling/superheat) depending on metering device in accordance with ANSI/ACCA Standard 5 Heating and cooling refrigerant lines will be insulated	Ensure proper equipment operation Prevent energy loss and condensation		6205
5.3088.2d Hot humid	Refrigerant will be weighed into HVAC systems when outdoor temperatures do not facilitate accurate testing of system charge Verification of proper charge will be conducted when outdoor temperatures are suitable Refrigerant charge evaluation will be done using proper evaluation techniques (subcooling/superheat) depending on metering device in accordance with ANSI/ACCA Standard 5	Ensure proper equipment operation		6206

5.3088.2e Marine	Refrigerant will be weighed into HVAC systems when outdoor temperatures do not facilitate accurate testing of system charge Verification of proper charge will be conducted when outdoor temperatures are suitable Refrigerant charge evaluation will be done using proper evaluation techniques (subcooling/superheat) depending on metering device in accordance with ANSI/ACCA Standard 5	Ensure proper equipment operation		6207
5.3088.2f Hot dry	Refrigerant will be weighed into HVAC systems when outdoor temperatures do not facilitate accurate testing of system charge Verification of proper charge will be conducted when outdoor temperatures are suitable Refrigerant charge evaluation will be done using proper evaluation techniques (subcooling/superheat) depending on metering device in accordance with ANSI/ACCA Standard 5	Ensure proper equipment operation		6208

5.3088.3 Regional Climatic Considerations—Mid and High Rise

Topic: Forced Air

Subtopic: Special Considerations

Desired Outcome: Regional climatic variables are taken into consideration

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3088.3a Very cold	Individual rooms will remain at a pressure differential of no greater than +/-3 pascals with reference to the indoors Combustion inlets and outlets will be terminated above snow line and protected from snow cover Roof exhaust fans will be installed with roof curbs that meet or exceed the mechanical code requirements Proper refrigerant charge will be evaluated and documented according to ANSI/ACCA Standard 5	Avoid moisture-related damage to the building Ensure occupant safety by properly venting combustion gasses Ensure proper exhaust air flow		6209

	Examples of acceptable procedures that may be performed include: • Refrigerant will be weighed into heating, ventilation, and air conditioning (HVAC) systems when outdoor temperatures do not facilitate accurate testing of system charge • Verification of proper charge will be conducted when outdoor temperatures are suitable • Refrigerant charge evaluation must be done using proper evaluation techniques (subcooling/superheat) depending on metering device in accordance with ANSI/ACCA Standard 5			
5.3088.3b Cold	Combustion inlets and outlets will be terminated above snow line and protected from snow cover Roof exhaust fans will be installed with roof curbs that meet or exceed the mechanical code requirements Proper refrigerant charge will be evaluated and documented according to ANSI/ACCA Standard 5. Examples of acceptable procedures that may be performed include: • Refrigerant will be weighed into HVAC systems when outdoor temperatures do not facilitate accurate testing of system charge • Verification of proper charge will be conducted when outdoor temperatures are suitable • Refrigerant charge evaluation must be done using proper evaluation techniques (subcooling/superheat) depending on metering device in accordance with ANSI/ACCA Standard 5	Ensure occupant safety by properly venting combustion gasses Ensure proper exhaust air flow		6210
5.3088.3c Mixed humid	Proper refrigerant charge will be evaluated and documented according to ANSI/ACCA Standard 5	Ensure proper equipment operation Prevent energy loss and condensation		6211

	Examples of acceptable procedures that may be performed include: • Refrigerant will be weighed into HVAC systems when outdoor temperatures do not facilitate accurate testing of system charge • Verification of proper charge will be conducted when outdoor temperatures are suitable • Refrigerant charge evaluation must be done using proper evaluation techniques (subcooling/superheat) depending on metering device in accordance with ANSI/ACCA Standard 5 • Heating and cooling refrigerant lines will be insulated			
5.3088.3d Hot humid	Proper refrigerant charge will be evaluated and documented according to ANSI/ACCA Standard 5 Examples of acceptable procedures that may be performed include: • Refrigerant will be weighed into HVAC systems when outdoor temperatures do not facilitate accurate testing of system charge • Verification of proper charge will be conducted when outdoor temperatures are suitable • Refrigerant charge evaluation must be done using proper evaluation techniques (subcooling/superheat) depending on metering device in accordance with ANSI/ACCA Standard 5 • Heating and cooling refrigerant lines will be insulated	Ensure proper equipment operation Prevent energy loss and condensation		6212
5.3088.3e Marine	Proper refrigerant charge will be evaluated and documented according to ANSI/ACCA Standard 5 Examples of acceptable procedures that may be performed include: • Refrigerant will be weighed into HVAC systems when outdoor temperatures do not	Ensure equipment durability Ensure system operates efficiently Avoid damage to the system		6213

	facilitate accurate testing of system charge • Verification of proper charge will be conducted when outdoor temperatures are suitable • Air conditioning/heating coils that are to be installed outside will be selected to withstand corrosion			
5.3088.3f Hot dry	Proper refrigerant charge will be evaluated and documented according to ANSI/ACCA Standard 5 Examples of acceptable procedures that may be performed include: • Refrigerant will be weighed into HVAC systems when outdoor temperatures do not facilitate accurate testing of system charge • Verification of proper charge will be conducted when outdoor temperatures are suitable • Refrigerant charge evaluation must be done using proper evaluation techniques (subcooling/superheat) depending on metering device in accordance with ANSI/ACCA Standard 5 • Heating and cooling refrigerant lines will be insulated	Ensure proper equipment operation Prevent energy loss		6214

5.3102.1 Replacement with Hot Water Boiler

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Installation

Desired Outcome: Proper installation and operation of new boiler

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

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3102.1a Assessment	Confirmation of the scope of work will be made for the following: • Clearances • Proper drainage in boiler room • Flue/chimney conditions	Verify scope of work		6215

	• Electrical capacity • Oil/gas availability • Piping connections			
5.3102.1b Boiler sizing calculation	Heat load calculations will be confirmed based on ACCA Manual J (for residential applications), Manual N, or ASHRAE equivalent (for commercial applications) and ASHRAE Standard 183 (for high rise application) Sizing will be confirmed for combined space heating and domestic hot water plant	Enable proper sizing of the heating appliance		6216
5.3102.1c Low mass selection	Low mass (water volume and heat exchanger) boilers will be selected whenever possible A primary/secondary piping configuration will be utilized when low mass systems are selected A low loss header will be utilized for primary/secondary piping configurations	Ensure longer life and improved durability of equipment Maximize efficiency of system Reduce short cycling of boiler		6217
5.3102.1d Multiple boilers/sequencing	Boiler control package will be used for outdoor water reset, lead-lag, and sequencing capabilities An authorized boiler manufacturer technician will be responsible to set up and demonstrate/ensure optimal sequencing and lead-lag operation	Ensure highest efficiency and performance of the systems Reduce short cycling of boiler		6218
5.3102.1e Fuel switching	Chimney will be assessed for proper sizing, lining, and draft	Ensure equipment and system components are compatible with new fuel		6219
5.3102.1f Hazardous material removal	Health concerns in the removal and replacement of equipment will be identified Written notification of hazardous material will be provided to the property manager/occupant Contact information for the regional EPA asbestos coordinator will be provided Asbestos abatement will be conducted by an EPA-certified contractor before decommissioning and replacement Property manager/occupant will be asked to contract with an EPA-	Remediate health hazards using EPA-certified contractors		6220

	certified asbestos contractor to conduct asbestos removal			
5.3102.1g Decommissioning	Accepted industry procedures and practices will be followed to: • Remove old boiler and associated components • Seal any unused chimneys • Remove unused oil tank, piping, valves, and associated equipment	Ensure worker and occupant safety Provide timely and efficient removal of old equipment		6221
5.3102.1h New equipment installation	New boiler and associated components will be installed in compliance with ANSI/ACCA Standard 5 acceptable procedures and local mechanical codes Concrete pads will be in accordance with the Uniform Mechanical Code and local building codes All required operating and safety controls and boiler trim will be installed and set up in accordance with local code and manufacturer's requirements Water meter will be installed on the makeup water/incoming line to the boiler Isolation valves will be installed to allow for pressure testing of the boiler Hydrostatic testing (for site-built boilers) will be performed to confirm there are no water leaks in boiler	Ensure worker and occupant safety Ensure optimal operation of equipment Ensure site-built boiler does not leak		6222
5.3102.1i Flushing of system	Flush valve will be installed at the lowest point With the boiler isolated and the feed and flush valves open, keep feeding water to the system until drain water runs clear	Protect new and remaining equipment Conform to performance efficiency		6223
5.3102.1j Startup/skimming of boiler	When applicable, new boiler will be flushed and skimmed before hot water is released to the building for the first time in accordance with manufacturer specifications Startup will be performed in accordance with manufacturer specifications	Remove impurities Ensure longevity of equipment Ensure occupant safety Conform to performance efficiency		6224

	Combustion efficiency and safety testing will be performed at multiple firing rates: at two firing rates for "low- high-low" burners, and minimum three firing rates for fully modulating burners Post-installation test report will include: • Outdoor temperature • Draft • Carbon monoxide (ambient and in flue gases) • Oxygen (in flue gases) • Flue temp • PH level of boiler water • Smoke spot reading • For condensing boilers, include corresponding return water temp			
5.3102.1k Location of circulator	Circulator will be installed in very close proximity of the expansion tank such that it is pumping away from the expansion tank	Reduce maintenance Improve the efficiency of the system		6225
5.3102.1l Air separator	Air eliminator, microbubble or standard type, will be installed in accordance with manufacturer specifications Insulate air and dirt separator	Reduce maintenance Improve the efficiency of the system		6226
5.3102.1m Bladder expansion tank	Bladder expansion tanks will be installed in accordance with manufacturer's installation instructions When replacing a non-bladder type expansion tank with another non-bladder type, no air elimination equipment will be installed that releases air into atmosphere; only an air elimination device that releases air into the tank will be installed Makeup water feed will be installed to the expansion tank connection The expansion tank shall be pre-charged, at minimum, to building static pressure before it is connected to the system	Reduce maintenance Improve the efficiency of the system		6227
5.3102.1n Education	Completed work will be reviewed with the building/property	Ensure building/property management team and operations		6228

	management team and operations staff Copies of manuals for boiler and all other installed system components will be given to maintenance staff Building/property management team and operations staff will be educated on the safe and efficient operation and maintenance requirements of the installed item	staff is informed of the safe, efficient operation and maintenance requirements of the installed item		

5.3102.10 Installation of Combined Heat and Domestic Hot Water System (Hot Water)

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Installation

Desired Outcome: Installation of higher efficiency system

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3102.10a Check for presence of asbestos-containing materials (ACMs)	Potential ACMs will be handled in accordance with SWS 2.0110.2 Potential Asbestos-Containing Materials	Ensure a safe work environment		6280
5.3102.10b Assessment	Field and site conditions will be verified to determine if scope of work is applicable Space heating, domestic hot water (DHW) loads, and capacity of new equipment will be verified by a contractor	Ensure optimal system is applied		6281
5.3102.10c Decommissioning	Existing heating and DHW components, as identified by the scope of work, will be removed and disposed of in accordance with local codes and regulations	Ensure safe removal and disposal of orphaned equipment		6282
5.3102.10d Install combined system	Heating water system will be cleaned and flushed Strainers will be installed on boiler water supply side of indirect tank/heat exchanger and on inlet side of heating pump in accordance with manufacturer specifications Equipment will be installed in accordance with ANSI/ACCA Standard 5 or per scope of work	Ensure water system is clean Properly install system Ensure worker safety		6283

	and manufacturer specifications, and will include: • Boilers • New indirect tank or heat exchangers and storage tanks • Pumps • Controls • Expansion tanks • Flow controls • Insulation			
5.3102.10e Testing	System will be leak free Space heating and DHW system will be tested for proper and safe operation Performance will be in accordance with manufacturer specifications and confirmed by a contractor Water flow through the boiler, pressure, operating amperage, and voltage shall be measured in accordance with ANSI/ACCA Standard 5 or ANSI/ASHRAE Standard 111, and adjusted to meet design requirements The following control strategies will be confirmed by a contractor: • Winter and summer modes/ operation • DHW priority • Lead-lag/sequencing • Modulation • Indoor space temperature control • Outdoor reset control	Ensure system operates safely and efficiently		6284
5.3102.10f Education	Property manager will be educated on proper operation and maintenance	Maintain optimal performance		6285

5.3102.11 Flow Control Through Multiple Boilers in all Primary Configurations (Hot Water)

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Installation

Desired Outcome: Optimized flow through all boilers

TITLE	SPECIFICATION(S)	OBJECTIVE(S)

5.3102.11a Evaluate current boiler piping configuration	Existing piping and pump layout will be visually inspected and compared to manufacturer installation instructions	Identify required modifications necessary to be in accordance with manufacturer specifications		6286
5.3102.11b New boiler installation	Installation (e.g., specifications, work order, etc.) will be verified to be in accordance with manufacturer specifications, and water flow through tall boilers will be measured in accordance with ANSI/ACCA Standard 5 or ANSI/ASHRAE Standard 111 and adjusted to meet design requirements Proper flow rate through all boilers will be achieved through the use of equivalent piping length or balance valves	Make modifications to minimize water flow rate (maximize fluid's heat transfer, i.e. "delta T") to system design requirements and within manufacturer acceptable flow range		6287
5.3102.11c Optimize existing boiler flow	Flow rate will be measured and compared to manufacturer optimal requirements Optimal flow rates will be achieved through the use of equivalent piping length or balance valves	Make modifications to minimize water flow rate (maximize delta T across boiler) to system design requirements and within manufacturer acceptable flow range		6288

5.3102.12 Flow Control Through Multiple Boilers in Primary/Secondary Configurations (Hot Water)

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Installation

Desired Outcome: Optimized flow through all boilers

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3102.12a Evaluate current boiler piping configuration	Existing piping and pump layout will be visually inspected and compared to manufacturer installation instructions	Identify required modifications necessary to be in accordance with manufacturer specifications		6289
5.3102.12b New boiler installation	Installation (e.g., specifications, work order) will be verified to be in compliance with manufacturer specifications, and water flow through tall boilers will be measured in accordance with ANSI/ACCA Standard 5 or ANSI/ASHRAE Standard 111 and adjusted to meet design requirements	Make modifications to minimize water flow rate (maximize fluid's heat transfer, i.e. "delta T") within manufacturer acceptable flow range		6290

	Proper flow rate of all boilers will be achieved through the use of equivalent piping length, balance valves, or individual circulation pumps (each furnished with balance and check valve or speed control and check valve)			
5.3102.12c Optimize existing boiler flow	Flow rate will be measured and compared to manufacturer optimal requirements Optimal flow rates will be achieved through the use of equivalent piping length, balance valves, or individual circulation pumps (each furnished with balance and check valve or speed control and check valve)	Make modifications to minimize water flow rate (maximize fluid's heat transfer, i.e. "delta T") within manufacturer acceptable flow range		6291

5.3102.14 Expansion Tank Installation (Hot Water)

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Installation

Desired Outcome: Accommodate the expansion and contraction of the system fluid

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3102.14a Check for presence of asbestos-containing materials (ACMs)	Potential ACMs will be handled in accordance with SWS 2.0110.2 Potential Asbestos-Containing Materials	Ensure a safe work environment		6292
5.3102.14b Size tank	Location of expansion tank and operational characteristics (system volume, operating temperature range, operating pressure range, and fluid type) will be used to determine size of tank	Select an appropriately sized tank		6293
5.3102.14c Isolate installation location	Nearest valves on either side of installation location will be closed	Eliminate water supply to the installation location		6294
5.3102.14d Install tank	Tank will be connected to existing system piping in accordance with manufacturer specifications	Properly install expansion tank		6295
5.3102.14e Pressurize tank	Expansion tank will be pressurized in accordance with manufacturer specifications to the appropriate system operating pressure	Pressurize the tank to the standard operating pressure		6296

	System will be filled and air will be eliminated			
5.3102.14f Reinsulate area	Where insulation was removed, piping will be reinsulated with new insulation to IECC and ASHRAE 90.1, at a minimum	Reduce energy loss Maintain safe surface temperature		6297
5.3102.14g Education	Completed work will be reviewed with the building/property management team and operations staff Building/property management team and operations staff will be educated on the safe and efficient operation and maintenance requirements of the installed item	Ensure building/property management team and operations staff is informed of the safe, efficient operation and maintenance requirements of the installed item		6298

5.3102.15 Bladder-Type Expansion Tank Pressurization (Hot Water)

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Installation

Desired Outcome: Allow for accommodation for the expansion and contraction of the system fluid

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3102.15a Check for presence of asbestos-containing materials (ACMs)	Potential ACMs will be handled in accordance with SWS 2.0110.2 Potential Asbestos-Containing Materials	Ensure a safe work environment		6299
5.3102.15b Isolate expansion tank	Expansion tank valve will be closed Existing water will be drained from expansion tank	Remove system pressure from expansion tank and drain tank		6300
5.3102.15c Repressurize tank	Expansion tank will be repressurized in accordance with manufacturer specification to appropriate system operating pressure Expansion tank bladder will be replaced in accordance with manufacturer specifications or entire tank will be replaced if unable to maintain required air pressure System will be refilled and air will be eliminated	Pressurize the tank to standard operating pressure		6301
5.3102.15d Education	Completed work will be reviewed with the building/property	Ensure building/property management team and operations		6302

	management team and operations staff Building/property management team and operations staff will be educated on the safe and efficient operation and maintenance requirements of the installed item	staff is informed of the safe, efficient operation and maintenance requirements of the installed item		

5.3102.16 Installation of Individual and Redundant Pumps

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Installation

Desired Outcome: Fluid circulation

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3102.16a Check for presence of asbestos-containing materials (ACMs)	Potential ACMs will be handled in accordance with SWS 2.0110.2 Potential Asbestos-Containing Materials	Ensure safe work environment		6303
5.3102.16b Assess location for pump	System schematics, manufacturer specifications, and physical locations will be reviewed to identify proper and serviceable locations	Ensure proper placement of pump		6304
5.3102.16c Install pump	When possible, pump will be installed in a physical location that is easy to access for maintenance purposes and in accordance with manufacturer specifications, paying special attention to the pump orientation Base-mounted pumps will be installed on concrete pads Base-mounted pumps will be connected to the system piping with vibration isolators Isolation valves, balance valves, strainers, pressure gauges, and motor starters/variable frequency drives (VFDs) will be installed in accordance with applicable specifications: SWS 5.3103.1 Balancing Valve Installation, SWS 5.3103.7 Instatllion of Pressure Gauges, SWS 5.3103.8 Isolation Valve Installation, SWS 5.3103.9 Installation of Strainers, SWS	Properly install pumping system		6305

	5.3102.8 Replacement of Conventional Pumps with Electrically Commutated Motor-Drive Pumps (Hot Water), SWS 5.3102.9 Installation and Control of Variable Frequency Drives (Hot Water), SWS 5.3102.33 Optimize Varaiable Frequency Drive Control Other electrical devices and installation requirements will be in accordance with local codes and jurisdictions			
5.3102.16d Install redundant pumps	When possible, pump will be installed in a physical location that is easy to access for maintenance purposes and in accordance with manufacturer specifications, paying special attention to the pump orientation Base-mounted pumps will be installed on concrete pads Base-mounted pumps will be connected to the system piping with vibration isolators Isolation valves, balance valves, strainers, check valves, pressure gauges, and motor starters/VFDs will be installed in accordance with applicable specifications: SWS 5.3103.1 Balancing Valve Installation, SWS 5.3103.7 Installation of Pressure Guages, SWS 5.3.103.8 Isolation Valve Installation, SWS 5.3103.9 Installation of Strainers, SWS 5.3102.8 Replacement of Conventional Pumps with Electrically Commutated Motor-Driven Pumps (Hot Water), SWS 5.3102.9 Installation and Control of Variable Frequency Drives (Hot Water), SWS 5.3102.33 Optimize Variable Frequency Drive Control Isolation valves, balance valves, strainers, check valves, pressure gauges, and motor starters/VFDs will be installed in accordance with applicable specifications: SWS 5.3103.1 Balancing Valve Installation, SWS 5.3103.7 Installation of Pressure Guages, SWS	Properly install redundant pumping system		6306

	5.3.103.8 Isolation Valve Installation, SWS 5.3103.9 Installation of Strainers, SWS 5.3102.8 Replacement of Conventional Pumps with Electrically Commutated Motor-Driven Pumps (Hot Water), SWS 5.3102.9 Installation and Control of Variable Frequency Drives (Hot Water), SWS 5.3102.33 Optimize Variable Frequency Drive Control Lead-lag controls will be installed in accordance with SWS 5.3102.7 Installation of Lead Lag Controls - Pumps Other electrical devices and installation requirements will comply with local codes and jurisdictions			
5.3102.16e Test pump	Water flow through the pump, head pressure, control sequences, operating amperage, and voltage shall be measured in accordance with ANSI/ACCA Standard 5 or ANSI/ASHRAE Standard 111 and adjusted to meet design requirements Pump (and lead-lag controller, if applicable) will be started in accordance with manufacturer specifications Pump performance will be verified	Ensure proper operation of pumping equipment		6307
5.3102.16f Insulate pump with removable and reusable insulation	Pump will be insulated with removable and renewable insulation to IECC and ASHRAE 90.1, at a minimum	Reduce energy loss Maintain safe surface temperature		6308
5.3102.16g Education	Completed work will be reviewed with the building/property management team and operations staff Building/property management team and operations staff will be educated on the safe and efficient operation and maintenance requirements of the installed item	Ensure building/property management team and operations staff is informed of the safe, efficient operation and maintenance requirements of the installed item		6309

5.3102.17 Mechanical Insulation—Removable and Reusable vs. Nonreusable (Fixed) Insulation

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Installation

Desired Outcome: Insulation maintained on all mechanical equipment and piping that requires insulation

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3102.17a Hazardous material removal	Health concerns in the disturbance, removal, and replacement of insulation will be identified Written notification of hazardous material will be provided to the building/property management team and operations staff and occupants (where applicable) Contact information for the regional EPA asbestos coordinator will be provided Asbestos abatement will be conducted by an EPA-certified contractor before decommissioning and replacement Occupant will be asked to contract with an EPA-certified asbestos contractor to conduct asbestos abatement, if applicable	Remediate health hazards using EPA-certified contractors		6310
5.3102.17b Nonreusable insulation	Nonreusable insulation will be installed on all insulated mechanical devices that do not require maintenance throughout the life of the device Installation of all nonreusable mechanical insulation will meet National Commercial and Industrial Insulation Standards (MICA Manual) as an industry standard All nonreusable mechanical insulation thicknesses will meet local applicable code requirements	Improve energy efficiency and reduce energy costs Maintain safe surface temperatures		6311
5.3102.17c Removable and reusable insulation	Removable and reusable insulation will be installed on all insulated mechanical devices that require maintenance throughout the life of the device Installation of all removable and reusable mechanical insulation will meet National Commercial and Industrial Insulation Standards (MICA Manual) as an industry standard	Improve energy efficiency and reduce energy costs Maintain safe surface temperatures		6312

	All removable and reusable mechanical insulation thickness will be in accordance with local applicable code requirements			
5.3102.17d Education	Completed work will be reviewed with the building/property management team and operations staff Building/property management team and operations staff will be educated on the safe and efficient operation and maintenance requirements of the installed item	Ensure building/property management team and operations staff is informed of the safe, efficient operation and maintenance requirements of the installed item		6313

5.3102.18 Flue Gas Condensate Treatment—Condensing

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Installation

For supporting material, see Building America Solution Center.

Desired Outcome: Safe management of flue gas condensate

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3102.18a Flue condensate drainage	All potential condensate collection (low) points in the flue system will be identified and adjusted to provide proper pitch as required by the manufacturer's requirements All condensate piping will be pitched toward the drain (refer SWS 5.3102.2 Venting Sealed Combustion Appliance)	Remove all flue gas condensation Ensure that all potential points of condensation collection are drained		6314
5.3102.18b Connection	Connections in condensate drain system will be watertight	Ensure condensate drain connections do not leak		6315
5.3102.18c Pumps	When approved by the local jurisdiction, condensate drain pumps will be installed when condensate cannot be drained by gravity Power source for pump will be installed Operation and drainage of pump will be verified	Ensure condensate properly drains		6316
5.3102.18d Vents and traps	Vents and traps will be installed on condensate drain lines Traps supplied with the equipment will be used in accordance with manufacturer specifications	Ensure condensate drain operates as designed Ensure condensate trap does not leak air		6317
5.3102.18e Termination	Condensate drain will be terminated in accordance with local codes	Ensure condensate does not leak to the building		6318

		Ensure condensate drain does not freeze		
5.3102.18f Floor drains	Floor drains will be in working condition	Ensure proper drainage of the room		6319
5.3102.18g Neutralization kit	Boiler manufacturer-specified neutralization kit will be installed between the boiler and the drain in accordance with manufacturer specifications Property manager/occupant will be educated on proper maintenance	Neutralized flue gas condensate before it is discharged into a drain Increase durability of equipment		6320
5.3102.18h Piping material	Piping material, located between boiler and neutralization kit, will be capable of withstanding acidic environments Piping material, located after neutralization kit and before floor drain, will be hard piped to withstand crushing and kinking	Ensure longevity of the piping Protect piping		6321
5.3102.18i Education	Completed work will be reviewed with the building/property management team and operations staff Building/property management team and operations staff will be educated on the safe and efficient operation and maintenance requirements of the installed item	Ensure building/property management team and operations staff is informed of the safe, efficient operation and maintenance requirements of the installed item		6322

5.3102.19 Replacement of Steam Boiler

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Installation

Desired Outcome: Proper installation and operation of new boiler

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3102.19a Assessment	Confirmation of the scope of work will be made for the following: • Clearances • Proper drainage in boiler room • Flue/chimney conditions • Electrical capacity • Oil/gas availability • Piping connections	Verify scope of work		6323

5.3102.19b Boiler size calculation	For one-pipe steam system, radiation survey will be completed, and appropriate piping and pickup factor (e.g., insulation, water volume, return line configuration) will be incorporated For two-pipe steam system: • Heat load calculations will be confirmed based on ACCA Manual J (for residential applications), Manual N, or ASHRAE equivalent (for commercial applications) and ASHRAE Std 183 (for high rise application) • Radiation survey will be completed, and appropriate piping and pickup factor (e.g., insulation, water volume, return line configuration) will be incorporated Sizing will be confirmed for combined space heating and domestic hot water plant	Enable proper sizing of the heating appliance		6324
5.3102.19c Removal of condensate tank	The selection of the boiler will be influenced/dictated as to whether the condensate tank could be eliminated from the system Selection will be based on: • Elevation of normal operating water level • Placement of the low water cutoffs • Elevation of lowest horizontal steam piping • Useable water volume of boiler	Lower cost while optimally designing system with fewer components Ensure proper design considerations to eliminate the need for the condensate tank and associated steam traps		6325
5.3102.19d Mass selection	Systems will be selected with higher mass heat exchangers A higher water volume boiler will be selected to ensure elimination of condensate return tanks (see also SWS 5.3102.19 Replacement of Steam Boiler)	Ensure longer life and improved durability of equipment Ensure the ability/option to remove condensate return tanks		6326
5.3102.19e Multiple boilers/sequencing	Multiple boiler system controls will be equipped with lead-lag and sequencing capabilities	Ensure highest efficiency and performance of the systems Ensure boilers do not short cycle		6327

	Systems will be set up to demonstrate/ensure optimal sequencing, and lead-lag will be accomplished			
5.3102.19f Fuel switching	Chimney will be assessed for proper sizing, lining, and draft	Ensure equipment and system components are compatible with new fuel		6328
5.3102.19g Hazardous material removal	Health concerns in the removal and replacement of equipment will be identified Written notification of hazardous material will be provided to the property manager/occupant Contact information for the regional EPA asbestos coordinator will be provided Asbestos abatement will be conducted by an EPA-certified contractor before decommissioning and replacement Property manager/occupant will be asked to contract with an EPA-certified asbestos contractor to conduct asbestos removal	Remediate health hazards using EPA-certified contractors		6329
5.3102.19h Decommissioning	Accepted industry procedures and practices will be followed to: • Remove old boiler and associated components • Seal any unused chimneys • Remove unused oil tank, piping, valves, and associated equipment	Ensure worker and occupant safety Provide timely and efficient removal of old equipment		6330
5.3102.19i New equipment installation	New boiler and associated components will be installed to accepted industry procedures and practices; in instances where conflicts occur between the code and the manufacturer's installation instructions, the more restrictive provisions shall apply (IPC 101.3 and UPC 101.2; IPC 301.7 and IPC 101.4) Concrete pads will be in accordance with the Uniform Mechanical Code and local building codes All required operating and safety controls and boiler trim will be installed and set up in accordance	Ensure worker and occupant safety Ensure optimal operation of the equipment Ensure site-built boiler does not leak		6331

	with manufacturer and local code requirements Near boiler piping will be installed in accordance with the manufacturer's recommendation All existing and new uninsulated steam, domestic hot water, and condensate piping in the boiler room will be insulated to code minimum Water meter will be installed on the makeup water/incoming line to the boiler so that it is capable of metering all water coming into the boiler, including both automatic feed or manual feed; this water meter should not be capable of being bypassed Boiler will be installed so that it does not cause water hammer or overfilling Isolation valves will be installed to allow for pressure testing of the boiler Hydrostatic testing (for site-built boiler) will be performed to confirm there are no water leaks in the boiler			
5.3102.19j Flushing of system	Isolation valve will be installed at the lowest point and immediately upstream of the Hartford loop Flush valve will be located upstream of newly installed isolation valve With the isolation valve to boiler closed and flush valve open, system will be run until drain water runs clear	Protect new and remaining equipment Conform to performance efficiency		6332
5.3102.19k Startup/skimming of boiler	In accordance with manufacturer specifications, the new boiler will be flushed and skimmed before steam is released to the building for the first time Proper startup will be done in accordance with manufacturer specifications Steady state combustion efficiency and safety testing will be performed at multiple firing rates; a minimum of two tests, one at high fire and one at low fire, will	Remove impurities Ensure longevity of equipment Ensure occupant safety Conform to performance efficiency		6333

	be performed for low-high-low burner, and a minimum of three tests (low fire, medium fire, and high fire) will be performed for fully modulating burners			
5.3102.19l Education	Completed work will be reviewed with the building/property management team and operations staff Building/property management team and operations staff will be educated on the safe and efficient operation and maintenance requirements of the installed item	Ensure building/property management team and operations staff is informed of the safe, efficient operation and maintenance requirements of the installed item		6334

5.3102.2 Venting Sealed Combustion Appliance

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Installation

Desired Outcome: Flue gases removed safely and cost-efficiently

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

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3102.2a Flue vent material selection	Flue vent material will be selected to prevent flue gas freezing and/or corrosion (double wall where necessary) in accordance with the appliance manufacturer's requirements	Ensure the durability of flue vent system Ensure selected material is appropriate and cost-effective		6229
5.3102.2b Location of vent termination	Termination will be located away from windows, doors, walkways, or any air intake opening in accordance with applicable codes and manufacturer's instructions Aesthetics and noise should be considered	Ensure vent termination does not create safety hazard		6230
5.3102.2c Location of venting path	Venting will be routed in the shortest and most direct path possible in accordance with applicable codes and manufacturer's instructions	Successfully remove flue gases and moisture		6231
5.3102.2d Connection points/joints	Vent joints will be airtight and watertight in accordance with applicable codes and manufacturer's instructions	Ensure safe operation		6232
5.3102.2e Pitch of flue connection	Vent will be pitched back to the boiler for categories I, II, and III	Ensure proper draft Ensure proper condensate management		6233

	Vent for category IV will be pitched in accordance with manufacturer specifications			

5.3102.20 Boiler—Pressure Relief Safety Valve—Steam Boilers Certified

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Installation

Desired Outcome: Pressure relief valve properly installed

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3102.20a Check for presence of asbestos-containing materials (ACMs)	Potential ACMs will be handled in accordance with SWS 2.0110.2 Potential Asbestos-Containing Materials	Ensure a safe work environment		6335
5.3102.20b Assessment	Available plans will be reviewed to assess system design and intent (e.g., total relief capacity in steam volume and number of valves required for code compliance)	Ensure specified valve meets relief requirements of the system		6336
5.3102.20c Install valves	Pressure relief valves will be installed in accordance with manufacturer specifications and in compliance with local codes	Properly install pressure relief valves		6337
5.3102.20d Discharge tube	Discharge tube will be in place, intact, and installed as sized Discharge tube will be the same size as pressure relief valve outlet Discharge tube will be properly secured to prevent damage Discharge tube termination will be in accordance with applicable codes	Ensure valve discharges to a safe location		6338
5.3102.20e Verification	Visually confirm the pressure temperature valve is rated per manufacturer's recommendation or per local code	Ensure valve discharges and reseats at specified pressure		6339
5.3102.20f Education	Completed work will be reviewed with the property manager Property manager will be educated on the safe and efficient operation and maintenance requirements of the installed item	Ensure building/property management team and operations staff is informed of the safe, efficient operation and maintenance requirements of the installed item		6340

5.3102.21 Steam Boiler Pressure Operating Controls (Steam)

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Installation

For supporting material, see Building America Solution Center.

Desired Outcome: Optimize boiler efficiency and prevent short cycling

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3102.21a Assessment	Controls specified for replacement will be confirmed Correct installation of remaining existing controls will be confirmed Current settings will be documented	Document status of existing controls		6341
5.3102.21b Repair	Existing installation will be corrected if: • Pressure control is mercury type, then the anti-siphon piping will be installed perpendicular to the control so that the pressure control stays level • Settings do not match specified scope of work	Ensure boiler operates at the lowest pressure Reduce short cycling		6342
5.3102.21c Replacement of pressure control	Existing controls will be removed All new pressure controls will be free of mercury New control will be installed above the boiler water line in accordance with manufacturer specifications New control will be set to pressure settings stated on scope of work	Ensure boiler operates at the lowest pressure Reduce short cycling		6343
5.3102.21d Disposal of mercury-containing pressure control	Removed pressure control will be disposed of in accordance with EPA guidelines	Prevent mercury from entering the environment		6344
5.3102.21e Testing	Pressure gauges will be checked for accuracy Contractor will observe and confirm boiler operation over a minimum of three cycles Safety control will be tested to ensure the burner shuts off at high limit	Ensure proper installation Ensure proper and safe operation		6345
5.3102.21f Education	Property manager will be educated on the operation and purpose of controls and settings	Ensure the proper use of controls Maintain optimal pressure settings		6346

5.3102.22 Steam to Domestic Hot Water Heat Exchanger (Steam)

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Installation

Desired Outcome: Increased efficiency of domestic hot water production

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3102.22a Assessment	Assessment will be conducted to determine whether alternative options for providing domestic hot water exist, such as: • Separate direct-fired unit (SWS 7.8102.4 Storage Tank-Type Water Heater) • Boiler with indirect water heater (SWS 5.3102.10 Installation of Combined Heat and Domestic Hot Water System (Hot Water))	Ensure optimal system is applied		6347
5.3102.22b Replacement	Selected heat exchanger will be of a higher efficiency/effectiveness Internal leaks will be checked by a contractor before new unit is put into service Isolation valves will be installed for proper servicing Gauges and insulation will be installed and functioning	Increase efficiency Ensure supply of safe domestic hot water by eliminating cross contamination Ensure ease of access, operation and maintenance		6348
5.3102.22c Testing	Domestic hot water production, distribution system, and delivery temperature will be tested for proper and safe operation	Ensure system operates safely and efficiently		6349
5.3102.22d Control recalibration	If alternative, stand-alone domestic hot water production system is selected, burner controls will be adjusted to address remaining heating load	Ensure heating system is optimized		6350
5.3102.22e Education	Property manager will be educated on proper operation and maintenance of heat exchanger	Maintain optimal performance		6351

5.3102.23 Insulation of Condensate Tank and Boiler Feed

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Installation

Desired Outcome: Tank heat loss reduced

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3102.23a Hazardous material	Potential ACMs will be handled in accordance with SWS 2.0110.2 Potential Asbestos-Containing Materials Hazardous materials will be handled in accordance with applicable local laws and codes before work will begin	Ensure safe environment and work place		6352
5.3102.23b New tank (tank already installed)	Tank will be clean and leak free before installing insulation Tank and associated piping/connections will be continuously and completely insulated to material and thickness in accordance with ASHRAE 90.1 Insulation will be covered by a water-resistant shell/layer/ insulation jacket	Insulate tank to applicable standard Protect feed water pump		6353
5.3102.23c Existing tank without insulation	Tank will be clean and leak free before installing insulation Tank and associated piping/connections will be continuously and completely insulated to material and thickness in accordance with ASHRAE 90.1 Insulation will be covered by a water-resistant shell/layer/ insulation jacket	Insulate tank to applicable standard Protect feed water pump		6354
5.3102.23d Insulation replacement	Existing insulation will be safely removed and properly disposed of Tank will be clean and leak free before installing insulation Tank and associated piping/connections will be continuously and completely insulated to material and thickness in accordance with ASHRAE 90.1 Insulation will be covered by a water-resistant shell/layer/ insulation jacket	Ensure worker safety Ensure proper disposal of older material Insulate tank to applicable standard Protect feed water pump		6355
5.3102.23e Education	Any insulation removed will be replaced to meet or exceed ASHRAE 90.1	Maintain insulation integrity for the life of the equipment		6356

5.3102.24 Advanced Combustion Controls

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Installation

Desired Outcome: Optimized boiler efficiency

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3102.24a Draft controls	Assessment: Feasibility of installing specified draft controls will be determined by site conditions Installation: Factory-installed draft devices in the boiler will be set, adjusted, and coordinated with the newly added draft control device Draft controls will be installed in accordance with manufacturer specifications regarding location and configuration If motorized, draft device components (e.g., pressure sensors) will be installed in accordance with manufacturer specifications and interlocked with burner operation Motorized damper will fully close when burner is not operating Hard piping will be used where pressure measurements/signals are required for proper operation Startup and test of any advanced draft control device will be performed by factory-authorized technician Testing: Draft control and excess air will be tested to verify they are operating within their required ranges Testing will be performed for firing ranges specified in the scope of work and when burner is not firing Testing will be performed to confirm burner is interlocked with controller	Ensure feasibility of the work order Minimize overdrafting Optimize efficiency		6357
5.3102.24b Linkage-less burner control with variable frequency drive (VFD)	Assessment: Feasibility of installing specified linkage-less burner/ VFD controls will be determined by site conditions Installation: Linkage-less burner control(s)/ VFD will be installed in accordance with manufacturer specifications Linkage-less burner control/ VFD will be installed to operate within the burner manufacturer-specified turndown ratio Startup and testing of any linkage-less burner control device/VFD will	Ensure feasibility of the work order Minimize excess air Optimize efficiency		6358

	be performed by factory-authorized technician VFD will be controlled in accordance with linkage-less burner control manufacturer specifications Testing: Linkage-less burner control, VFD, and excess air will be tested to verify they are operating within required ranges Testing will be performed for firing ranges specified in the scope of work Linkage-less burner controls/ VFD will be tested with all fuel types			
5.3102.24c Oxygen (O2) trim	Assessment: Feasibility of installing specified oxygen (O2) trim will be determined by site conditions Installation: O2 trim controls and required accessories (e.g., O2 sensors) will be installed in accordance with manufacturer specifications O2 trim control will be installed to operate within both the burner and O2 trim control manufacturer-specified turndown ratio Startup and testing of any O2 trim control device will be performed by factory-authorized technician; where a factory-authorized technician is not available, this work will be performed by "qualified person," as defined by NFPA 31, 3.3.50 O2 trim, VFD, and linkage-less control will be interlocked and coordinated in accordance with manufacturer specifications Testing: Testing will be done to verify that O2 level is maintained in accordance with manufacturer specification throughout the burner firing range Testing will be done to verify that O2 level is maintained in accordance with manufacturer specification during mild weather and extreme cold/design temperatures before warranty period ends Linkage-less burner controls/VFD/O2 trim control will be tested with all	Ensure feasibility of the work order Minimize excess air Optimize efficiency		6359

	fuel types anticipated for use in the application			
5.3102.24d Education	Property manager will be educated on the cleaning, calibration, and maintenance of all sensors and gauges in accordance with manufacturer specifications	Maintain peak performance		6360

5.3102.25 Installation of Lead—Lag Controls for Boilers

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Installation

Desired Outcome: Minimize cyclic boiler operation, increase system efficiency and boiler life

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3102.25a Equipment selection	Optimum combination of boiler sizes and firing rate turndown ratio will be determined to match the seasonal heating load profile of the installation (consider boilers of varying size)	Minimize number of firing cycles in periods of light heating load		6361
5.3102.25b Controls selection	Lead-lag system will be selected to properly match the requirements of the equipment selected above, in terms of number of boilers and firing rate turndown ratio	Improved system efficiency and boiler life		6362
5.3102.25c Equipment and controls installation	Boilers, burners, and control system will be installed in accordance with relevant manufacturer specifications and local codes and standards	Ensure proper operation of equipment		6363
5.3102.25d Equipment and controls commissioning	Burner fuel turndown ratios will be set up in accordance with equipment selection criteria above Lead-lag system will be set up in accordance with manufacturer specifications and system designer requirements Correct relationship between burner/boiler operating controls and modulating controls will be set to minimize cyclic operation using boiler manufacturer specifications where available	Maximize boiler life and system efficiency		6364
5.3102.25e Education	Completed work will be reviewed with the building/property management team and operations staff	Ensure building/property management team and operations staff is informed of the safe, efficient operation and maintenance requirements of the installed item		6365

	Building/property management team and operations staff will be educated on the safe and efficient operation and maintenance requirements of the installed item			

5.3102.26 Variable Frequency Drive Systems on Burners

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Installation

Desired Outcome: Compliance with Code Pre-Purge Requirement of Four Air Changes

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3102.26a Pre boiler startup	Burner recommendations referencing fan motor minimum hertz will be determined	Understand airflow control philosophy of burner manufacturer		6366
5.3102.26b Boiler/burner startup (commissioning)	Boiler/burner startup will be performed by burner manufacturer-designated technician; in the case there is none available from manufacturer, then the startup will be performed by "qualified person," as defined in NFPA 31, 3.3.50	Startup performed by properly qualified personnel		6367
5.3102.26c Burner fan speed control	Burner fan speed control will be set by technician to ensure burner is in accordance with manufacturer specifications, especially in terms of purge and combustion airflow rates across firing range, and to ensure four air change rule	Safe startup and operation of burner and boiler		6368
5.3102.26d Education	Completed work will be reviewed with the building/property management team and operations staff Building/property management team and operations staff will be educated on the safe and efficient operation and maintenance requirements of the installed item	Ensure building/property management team and operations staff is informed of the safe, efficient operation and maintenance requirements of the installed item		6369

5.3102.27 Burner Modulation Controls (Does not Include Burner Replacement)

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Installation

Desired Outcome: Optimized efficiency and prevention of short cycling

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3102.27a Assessment	Existing boiler, burner, gas valve, and gas pressure booster will be capable for modulation Compatibility between specified controls and existing burner will be confirmed Remaining existing controls will be confirmed as installed correctly Current settings will be documented	Document the status of existing controls		6370
5.3102.27b Repair	Existing installation will be corrected if settings do not match specified scope of work Appropriate repairs will be made to the following components in accordance with scope of work and manufacturer specifications: • Linkage • Gas/oil valves • Air damper on burner • Combustion controls	Ensure boiler modulates to optimize efficiency Reduce short cycling		6371
5.3102.27c Replacement of modulation control	Existing controls will be removed All new pressure controls will be free of mercury New controls will be installed in accordance with manufacturer specifications New control will be set to temperature settings (hot water boiler) and pressure settings (steam boiler) as stated on scope of work Applicable burner linkages, nozzles, cams, oil pump pressure setting, and gas valve will be adjusted to specified burner firing range	Ensure boiler modulates to optimize efficiency Reduce short cycling		6372
5.3102.27d Disposal of mercury-containing modulation control	Removed modulation control will be disposed of in accordance with EPA regulation	Prevent mercury from entering the environment		6373
5.3102.27e Upgrade/install modulation control	All new pressure controls will be free of mercury	Ensure boiler modulates to optimize efficiency Reduce short cycling		6374

	New controls will be installed in accordance with manufacturer specifications New control will be electrically connected to burner panel and supplied with power in accordance with manufacturer specifications New control will be set to temperature settings (hot water boiler) and pressure settings (steam boiler) as stated on scope of work Applicable burner linkages, nozzles, cams, oil pump pressure setting, and gas valve will be adjusted to specified burner firing range			
5.3102.27f Testing	For steam boiler, pressure gauges will be checked for accuracy For hot water boiler, pressure and temperature gauges will be checked for accuracy Contractor will observe and confirm boiler operation over a minimum of three cycles	Ensure proper installation Ensure proper operation		6375
5.3102.27g Education	Property manager will be educated on the operation and purpose of controls and settings	Ensure proper use of controls Maintain optimal settings to ensure modulation occurs		6376

5.3102.28 Burners

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Installation

Desired Outcome: Efficiencies safely maximized

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3102.28a Assessment	Inspections will be made based on ANSI/ASHRAE/ACCA Standard 180 Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems for commercial applications and ANSI/ACCA 4 Maintenance of Residential HVAC Systems for residential applications Examples of items to be addressed are as follows: • A review of site conditions and verification of efficiency	Determine if boiler replacement is needed Confirm feasibility of the scope of work Improve safety and efficiency		6377

	performance condition of burner shall be evaluated • Safety issues will be addressed			
5.3102.28b Service, upgrade, or replace burner	Inspections will be made based on ANSI/ASHRAE/ACCA Standard 180 Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems for commercial applications and ANSI/ACCA 4 Maintenance of Residential HVAC Systems for residential applications Examples of items to be addressed are as follows: • Combustion air intake dampers • Fuel/air modulating • Electronic ignition • Linkage-less fuel/air control • Oxygen trim • Variable frequency drives • Low nitrogen oxide (replacement burner) • High turndown ratio burner If not present or in scope of work, above upgrades will be considered Short cycling will be eliminated	Improve safety and efficiency Identify opportunities for upgrades		6378
5.3102.28c Combustion efficiency	Undiluted flue gases will be checked with a calibrated flue gas analyzer in accordance with accepted protocol If combustion is not occurring safely or with maximum efficiency, diagnostics and adjustments will be done in accordance with work order specifications Fuel/air ratio will be adjusted to meet specified performance over a range of firing rates, when applicable	Confirm that combustion occurs safely with maximum efficiency		6379
5.3102.28d Modulation	Contractor will demonstrate the burner modulates over the specified operating range (steam pressure and water temperature) and firing rates Combustion efficiency will match work order specifications over specified firing rates or turndown ratios	Engage and optimize modulation		6380
5.3102.28e Education	Building operations staff will be educated on burner capabilities and ongoing maintenance	Maintain optimal performance		6381

5.3102.28f Startup	Startup will be performed by "qualified person," as defined in NFPA 31, 3.3.50	Ensure proper installation and setup		6382
5.3102.28g Fuel	Where applicable, dual fuel systems will be recommended when replacing oil-fired burners Dual fuel switch control operation will be confirmed	Ensure fuel flexibility		6383

5.3102.29 Gas Trains and Gas Boosters (Water and Steam)

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Installation

Desired Outcome: Safe and optimal gas supply to all gas-fired equipment

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3102.29a Assessment	Existing gas piping will provide appropriate pressure and supply rate for boilers per scope of work Existing gas line will be leak free Leaks will be repaired before proceeding Adequacy of gas service will be confirmed Gas pressure booster will be removed whenever possible If a gas pressure booster is necessary, compatibility will be confirmed with the newly specified gas-fired equipment Low and high gas pressure switches will be checked for proper operation	Ensure safe and proper gas supply to equipment		6384
5.3102.29b Gas valves	Gas valves will be removed and replaced in accordance with manufacturer specifications	Provide gas to burner when there is a call for heat Control volume of gas for burner Ensure the safe shut off of gas once heat is turned off		6385
5.3102.29c Location	Gas train will be located/installed to not create a trip hazard or be damaged by water	Ensure worker safety Ensure durability of equipment		6386
5.3102.29d New gas piping and pressure regulators	Gas pressure regulators requiring venting will be vented to the outdoors with a rigid pipe Gas train components, pipe material, and pipe sizing will comply with all applicable codes or local ordinance	Deliver adequate gas pressure to boiler		6387
5.3102.29e Testing	For newly installed systems, gas train will be pressure-tested for leaks	Ensure safe operating conditions		6388

	For existing systems, gas train will be tested for leaks in accordance with local utility requirements Gas pressure and supply rates will be tested to confirm they comply to specified scope of work and burner requirements			
5.3102.29f Education	Building/property management team and operations staff will be educated on the operation of the high and low gas pressure switches, gas valve, gas pressure booster, and gas regulator Building/property management team and operations staff will be educated on the indications of raw gas leaks	Ensure building/property management team and operations staff and occupant safety Maintain proper operation of gas train		6389

5.3102.3 Boiler—Pressure and Temperature Relief Valve—Hot Water Boilers

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Installation

Desired Outcome: Pressure and temperature relief valve properly installed

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3102.3a Check for presence of asbestos-containing materials (ACMs)	Potential ACMs will be handled in accordance with SWS 2.0110.2 Potential Asbestos-Containing Materials	Ensure a safe work environment		6234
5.3102.3b Assessment	Available plans will be reviewed to assess system design and intent (e.g., total relief capacity in water volume and the pressure rating of the valve required for code compliance)	Ensure specified valve meets relief requirements of the system and is not grossly overrated for the system		6235
5.3102.3c Install valves	Pressure and temperature relief valves will be installed in accordance with manufacturer specifications and local codes	Properly install pressure and temperature relief valves		6236
5.3102.3d Discharge tube	Discharge tube will be in place, intact, and installed as sized Discharge tube will be the same size as pressure relief valve outlet Discharge tube will be properly secured to prevent damage	Discharge valve to a safe location		6237

	Discharge tube termination will be in accordance with local code and manufacturer's requirements			
5.3102.3e Verification	Visually confirm that the pressure temperature valve is rated per manufacturer's recommendation or per local code	Ensure valve discharges and reseats at specified pressure and temperature		6238
5.3102.3f Education	Completed work will be reviewed with the building/property management team and operations staff Building/property management team and operations staff will be educated on the safe and efficient operation and maintenance requirements of the installed item	Ensure building/property management team and operations staff is informed of the safe, efficient operation and maintenance requirements of the installed item		6239

5.3102.30 Controls—Energy Management Systems

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Installation

Desired Outcome: Install Energy Management Systems

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3102.30a Hazardous materials	Materials containing asbestos will be handled in accordance with SWS 2.0110.2 Potential Asbestos-Containing Materials Hazardous materials will be handled in accordance with applicable local laws and codes before work begins	Ensure safe environment and work place		6390
5.3102.30b Assessment and verification	Verify site conditions to assess whether the specified control system is compatible with the systems it will monitor and manage Existing electrical service will be verified for adequacy If electrical service is inadequate, the engineer will be notified and will only proceed after the engineer's approval and guidance of proper actions	Determine if specified control can be installed at the site and is the correct control system for the site		6391
5.3102.30c Installation of an energy management system (EMS)	Control panel will be mounted at a safe location to prevent damage to the control panel from water and/or excessive heat Location will be easily accessible and in close proximity of the door	Ensure the control is installed to achieve optimized savings and comfort		6392

	At minimum, the following sensors will be installed (all sensor wiring will be in metal conduit; all conduits will be secured to wall or metal strut or other acceptable surfaces): • Outside air temperature sensor • Stack temperature • Domestic hot water supply water temperature sensor • Apartment space temperature (minimum 25% of the residential units) • Boiler water temperature sensor • New make-up water meter • Boiler pressure sensor (steam boiler only) Outside air temperature sensor will be installed on the building exterior, 10 feet above grade, 4" away from the wall, on the north façade, and in shade; the wall penetration made to run the conduit will be sealed airtight with fire-rated material in accordance with applicable codes; sensor will be wired to the control panel Additional sensors and control points will be installed as required by the manufacturer to optimize system operation Control panel will be mounted on the wall, and all connected sensors will be wired to the control panel in accordance with manufacturer specifications Control panel will be energized, and all sensors will be checked for proper accuracy and communication			
5.3102.30d Testing and verification	Control panel will be exercised, sensors will be calibrated, remote communication will be confirmed, alarms will be set and tested, and entire system will be commissioned A complete installation and operations and maintenance manual will be provided to the client	Confirm system capabilities and functionalities		6393
5.3102.30e Education	Occupant will be involved in the initial programming of the control, control set points, remote login, monitoring, and control adjustment,	Educate client on best use		6394

	and educated on common settings and programming			

5.3102.31 Installation of Thermometers (Includes Hot Water)

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Installation

Desired Outcome: Accurate verification of system operating conditions

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3102.31a Check for presence of asbestos-containing materials (ACMs)	Potential ACMs will be handled in accordance with SWS 2.0110.2 Potential Asbestos-Containing Materials	Ensure a safe work environment		6395
5.3102.31b Determine locations for thermometers	Available plans will be reviewed to assess system design and intent Thermometer locations and conditions will be visually verified; thermometers will be located on the inlet and outlet of all heat transfer devices (e.g., boilers, heat exchangers, and coils) and the supply and return to all distribution loops	Determine minimum thermometer placement		6396
5.3102.31c Select appropriate thermometer (thermowell vs. strap-on)	Thermometer selection will be provided for accurate measurement with rapid response to temperature change Strap-on thermometers will be an option for copper piping applications Thermowell thermometers will be used in applications where piping diameter is 4" or larger	Ensure selected thermometer provides accurate temperature measurement with rapid response		6397
5.3102.31d Install thermowell when necessary	Nearest valves on either side of thermowell location will be closed Thermowell will be installed and extend midway into fluid flow System will be refilled and air will be eliminated	Properly install thermowell		6398
5.3102.31e Install thermometer	Strap-on thermometers will be attached tightly with heat transfer grease applied between sensing element and pipe	Properly install thermometers in selected locations		6399

	Thermowell thermometers will be installed with heat transfer grease between sensing element and thermowell Thermometers will be installed facing in such a manner so that minimum effort is required to read it			
5.3102.31f Reinsulate area	Where insulation was removed, sensing element and associated piping will be reinsulated with new insulation to IECC and ASHRAE 90.1, at a minimum	Reduce energy loss Maintain safe surface temperature		6400
5.3102.31g Education	Completed work will be reviewed with the building/property management team and operations staff Building/property management team and operations staff will be educated on the safe and efficient operation and maintenance requirements of the installed item	Ensure building/property management team and operations staff is informed of the safe, efficient operation and maintenance requirements of the installed item		6401

5.3102.32 Install Thermostatic Radiator Valves

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Installation

Desired Outcome: Established control of radiator heat output

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3102.32a Install thermostatic radiator valves (TRVs)	Potential asbestos-containing material will be handled in accordance with SWS 2.0110.2 Potential Asbestos-Containing Materials	Ensure a safe work environment		6402
5.3102.32b Assessment	Available plans will be reviewed to assess system design and intent If specified on hot water system, the contractor will check existing distribution piping layout to ensure that installation of these valves will not result in undesired outcomes, such as unintended flows through other branches/circuits If specified for one-pipe steam system, contractor will make sure valves will not be enclosed inside a radiator cover	Ensure specified valve meets design intent and desired outcome		6403

	If specified for one-pipe steam system, contractor will ensure that the correct valve type is recommended Contractor will assess whether the specified valve is the correct type so that the temperature sensor will not be enclosed or trapped behind furniture			
5.3102.32c Isolate TRV location	TRV location will be isolated. Nearest valves on either side of TRV location will be closed to isolate from the system	Eliminate water/steam supply to valve location		6404
5.3102.32d Install TRV	TRV will be installed in accordance with manufacturer specifications In applicable cases, system will be refilled and air will be eliminated	Allow distribution loop to bypass terminal unit/radiator and eliminate over- and under-heated zones		6405
5.3102.32e Testing and verification	Contractor will operate the system to verify there are no leaks and valve operations	Ensure there are no leaks in the system and that the valve is operating		6406
5.3102.32f Education	Completed work will be reviewed with the building/property management team and operations staff Building/property management team and operations staff will be educated on the safe and efficient operation and maintenance requirements of the installed item	Ensure building/property management team and operations staff is informed of the safe, efficient operation and maintenance requirements of the installed item		6407

5.3102.33 Optimize Variable Frequency Drive Control

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Installation

Desired Outcome: Varied distribution loop flow to minimize pumping energy

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3102.33a Verify proper placement, type, and condition of sensors	Sensor location, type, and condition will be assessed in accordance with selected control strategy	Determine condition and presence of existing sensors for variable frequency drive (VFD) operation		6408
5.3102.33b Install, repair, relocate, or	Sensors will be installed or replaced in accordance with manufacturer specifications and as required for selected control strategy	Ensure required sensors are properly located and functioning for VFD operation		6409

replace sensors as necessary				
5.3102.33c Initial setup of VFD	VFD parameters will be set up to accept feedback from sensors dependent upon chosen control strategy and to maintain minimum boiler and pump flows	Set initial parameters to maintain minimum system pumping requirements with reduced electrical energy use		6410
5.3102.33d Modify operating set points based on observed system performance	Accurate supply and return temperatures will be obtained and compared to design distribution loop temperature differential on representative mild, cold, and design temperature days Settings will be adjusted to maintain design distribution loop differential temperature on representative mild, cold, and design temperature days Minimum distribution loop water temperature requirement will be maintained Minimum boiler and pump flow rates will be maintained	Ensure optimal settings based on actual operating conditions to limit system from over pumping and to reduce the pump energy consumption while protecting the pump and boiler		6411
5.3102.33e Record and report settings	Observed supply, return, and outdoor temperatures and all control set points on representative mild, cold, and design temperature days will be documented and provided to building operations staff	Ensure written record of settings		6412
5.3102.33f Educate building operations staff	Building operations staff will be educated to operate VFD systems, including sensor location, control operation, and set points	Ensure continued optimized performance		6413

5.3102.34 Steam or Hot Water to Domestic Hot Water Heat Exchanger

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Installation

Desired Outcome: Increased efficiency of domestic hot water (*DHW*) production

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3102.34a Check for presence of asbestos-containing	Potential ACMs will be handled in accordance with SWS 2.0110.2 Potential Asbestos-Containing Materials	Ensure a safe work environment		6414

materials (ACMs)				
5.3102.34b Assessment	System schematics, manufacturer specifications, and physical locations will be reviewed to identify proper and serviceable locations Boiler manufacturer specifications will be reviewed for need of buffer tank; if required, buffer tank will be sized and installed in accordance with SWS 5.3188.2 Adding Mass to Low Mass Boiler - Existing or New	Ensure proper placement of DHW heater and system components		6415
5.3102.34c Installation of heater and piping components	DHW heater will be installed in accordance with SWS 5.3102.1 Replacement with Hot Water Boiler and SWS 5.3102.19 Replacement of Steam Boiler Thermometers, pressure gauges, steam trap(s) where applicable, and isolation valves will be installed in accordance with applicable standard work specifications: SWS 5. 3102.31 Installation of Thermometers (Includes Hot Water), SWS 5.3102.21 Steam Boiler Pressure Operating Controls (Steam), SWS 5.3103.6 Two Pipe Steam Systems - Steam Traps, SWS 5.3103.7 Installation of Individual and Rendundant Pumps Pumps and/or zone valves required for integration into distribution system will be installed in accordance with Pump and Zone Valve standard work specifications , sections 5.3104.6 and 5.3102.16)	Properly install heater, piping, and control components		6416
5.3102.34d Installation of controls	Pumps/zone valves, sensors/aquastats, and regulating valves will be connected to district steam piping, boiler/boiler sequencing controls in accordance with installation requirements; DHW prioritization will be verified, if applicable	Ensure generation of heat and domestic hot water with domestic hot water prioritization if it is applicable		6417
5.3102.34e Testing	Contractor will check for internal leaks before putting into service Water flow through the heat exchanger, pressure, operating amperage, and voltage shall be measured in accordance with	Ensure system operates safely and efficiently		6418

	ANSI/ACCA Standard 5 or ANSI/ASHRAE Standard 111 and adjusted to meet design requirements DHW production, distribution system, and delivery temperature will be tested for proper and safe operation			
5.3102.34f Optimization	Control set points will be reviewed for minimum safe boiler operation to provide DHW	Optimize boiler efficiency		6419
5.3102.34g Insulate modified system components	All devices requiring service will be insulated with removable and reusable insulation to IECC and ASHRAE 90.1, at a minimum All piping and fittings will be insulated with fixed insulation to IECC and ASHRAE 90.1, at a minimum	Reduce energy loss Maintain safe surface temperature		6420
5.3102.34h Education	Property manager will be educated in proper operation and maintenance of heat exchanger	Maintain optimal performance		6421

5.3102.35 Upgrade to a Combined Heat and Domestic Hot Water System

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Installation

Desired Outcome: Increased efficiency of existing system

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3102.35a Check for presence of asbestos-containing materials (ACMs)	Potential ACMs will be handled in accordance with SWS 2.0110.2 Potential Asbestos-Containing Materials	Ensure a safe work environment		6422
5.3102.35b Assessment	Field and site conditions will be verified to determine if scope of work is applicable It will be determined if higher efficiency system and optimal control strategy are possible Contractor will verify capacity of domestic hot water (DHW) and system choice	Ensure optimal system is applied		6423
5.3102.35c Decommissioning	Existing stand-alone DHW components, as identified by the scope of work, will be removed	Ensure safe removal and disposal of orphaned equipment		6424

	and disposed of in accordance with local codes and laws			
5.3102.35d Add indirect domestic hot water heater	Heating water system will be cleaned and flushed Strainer will be installed on boiler water supply side of heat exchanger in accordance with manufacturer specifications Equipment will be installed in accordance with manufacturer specifications and will include: • New indirect tank or heat exchanger and storage tank • Pumps • Controls • Expansion tank • Flow controls • Insulation Equipment will be installed on concrete pads as required; for applicable climates, freeze protection will be incorporated into the system using a glycol loop separated by heat exchanger or a drainback system	Ensure water system is clean Properly install system		6425
5.3102.35e Testing	DHW production, distribution system, and delivery temperature will be tested for proper and safe operation Water flow through the boiler, pressure, control sequences, operating amperage, and voltage shall be measured in accordance with ANSI/ACCA Standard 5 or ANSI/ASHRAE Standard 111 and adjusted to meet design requirements Contractor will confirm performance to manufacturer specifications Contractor will confirm intent of control strategy: • Winter and summer modes/ operation • DHW priority • Lead-lag/sequencing • Modulation	Ensure system operates safely and efficiently		6426
5.3102.35f Education	Property manager will be educated on proper operation and maintenance	Maintain optimal performance		6427

5.3102.36 Low Water Cutoffs

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Installation

Desired Outcome: Prevent boiler from dry firing

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3102.36a Primary low water cutoff	For steam boiler: Mechanical low water cutoff will be installed in accordance with applicable codes and manufacturer's instructions at the proper water level For hot water boiler: Mechanical low water cutoff, electronic probe-type low water cutoff, or flow switch protection (in the case of coil boilers) will be installed in accordance with manufacturer specifications A mechanical low water cutoff will be installed to include a discharge pipe and valve to allow for proper maintenance and safe discharge of boiler water during maintenance	Ensure burner will not fire under low water conditions Ensure water discharges safely Ensure proper location/ installation		6428
5.3102.36b Secondary low water cutoff	A secondary low water cutoff (electronic or mechanical) will be installed in accordance with applicable codes and manufacturer's instructions no more than 2" below the primary low water cutoff A manual reset will be included on all secondary low water cutoffs A secondary low water cutoff (electronic or mechanical) will be installed in accordance with applicable codes and manufacturer's instructions at or above the minimum safe water level as determined by the manufacturer; the primary low water cutoff shall be a minimum 2" above this elevation	Ensure backup to the primary system Ensure proper installation location Ensure water discharges safely		6429
5.3102.36c Control integration	If a central energy management system is available, low water cutoff will be connected to provide alarm	Support an immediate response to low water conditions		6430
5.3102.36d Testing low water cutoffs for steam	Primary low water cutoff: Water level will be reduced to test cutoff operation using the following sequence: • Operate boiler (burner)	Ensure proper working conditions Ensure proper discharge		6431

boilers only	• Open discharge valve • Note water level when burner stops firing Secondary low water cutoff: Secondary low water cutoff will be tested in a similar manner as the primary			
5.3102.36e Education	Completed work will be reviewed with the building/property management team and operations staff Building/property management team and operations staff will be educated on the safe and efficient operation and maintenance requirements of the installed item	Ensure building/property management team and operations staff is informed of the safe, efficient operation and maintenance requirements of the installed item		6432

5.3102.37 Controls—Thermostat Replacement

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Installation

Desired Outcome: Thermostat replaced when appropriate

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3102.37a Visual inspection	Thermostats will be visually located Replacement will be recommended if a digital, programmable thermostat is not present (Note: High mass, radiant systems may or may not benefit from programmable thermostats)	Determine if existing thermostats need to be replaced		6433
5.3102.37b Mercury assessment	Thermostats containing mercury will be identified and disposed of in accordance with EPA guidance	Protect workers and occupants from mercury exposure		6434
5.3102.37c Installation	Location for new thermostat will be determined in accordance with applicable codes and manufacturer's instructions The new thermostat will be located such that it is easily accessible for control without any need for step stool or ladder to comply with Federal Fair Housing Act Compatibility of the existing system with new thermostat will be verified (e.g., voltage, wiring, condition, location)	Achieve comfort and energy savings for the occupant		6435

	New thermostat will be installed			
5.3102.37d Testing	Heating system will be re-energized and cycled Thermostat will be programmed to occupant's lifestyle choices	Ensure safe and efficient operation		6436
5.3102.37e Disposal	Removed thermostats will be disposed of in accordance with EPA guidelines	Prevent mercury from entering the environment		6437
5.3102.37f Education	Building/property management team and operations staff and occupants will be involved in the initial programming of thermostat and educated on common settings and programming On new installs, building/property management team and operations staff and occupants will be encouraged to save the manual and keep it accessible	Educate building/property management team and operations staff and occupant on best use		6438

5.3102.38 Full Commissioning

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Installation

Desired Outcome: Control quality and optimize performance and safety

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3102.38a Commissioning team	When full commissioning is warranted, the commissioning team will be identified, and include commissioning agent, owner, property manager, contractor, engineer, architect, and building operations staff Scope of commissioning will be confirmed Roles and responsibilities will be identified For individual residential or light commercial installations, documentation, owner education, and training will be in accordance with procedures in ANSI/ACCA Standard 5	Assign commissioning responsibilities		6439
5.3102.38b Design intent and approach	Owner's project requirements and basis of design will be reviewed with commissioning team	Orient the installation contractor to the intent and design of the project		6440

	Site assessment will be reviewed and verified	Orient the property manager to the intent and design of the project		
5.3102.38c Design review	Control sequence will be reviewed with manufacturer, installation contractor, and building operations staff Work scope and design elements will be reviewed to include at a minimum: • Control sequence • Instrumentation • Coordination of controls and equipment	Ensure specified design is optimal for project		6441
5.3102.38d Submittals	Submittals will be supplied to the commissioning team for review and approval	Ensure specified materials are included for the project		6442
5.3102.38e Pre-functional checklist	Checklist will be created and approved by commissioning agent Checklist will be completed and submitted to commissioning team by installation contractor	Verify installation and startup		6443
5.3102.38f Functional test	Functional test procedure will be developed and approved Functional testing will be performed by a contractor and witnessed by commissioning agent Functional test will demonstrate sequence of control Contractor will correct any failures and retest	Ensure equipment/materials are working together in proper sequence and coordination Follow specified sequence of control		6444
5.3102.38g Documents	Operations and maintenance manual will be customized for project by installation contractor Operations and maintenance manual will be submitted to commissioning agent for approval Multiple copies of operations and maintenance manual will be provided to property manager Commissioning process binder will be provided to property manager by commissioning agent	Provide documentation for optimal operation and maintenance of equipment		6445
5.3102.38h Education	Contractor will be responsible for conducting/providing onsite education to the building operations staff on the operation and maintenance of the installed equipment	Educate building operations staff to operate and maintain the system for optimal performance		6446

	Building operations staff education will be witnessed by designated commissioning team members			
5.3102.38i Near end of warranty site visit	Inspection will occur (approximately 9 months after install or final equipment acceptance) before the warranty ends Contractor will resolve any outstanding issues before warranty ends	Resolve equipment issues before warranty ends		6447

5.3102.4 Hot Water Operating Controls—Aquastat (Hot Water)

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Installation

Desired Outcome: Optimize boiler efficiency and prevent of short cycling

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3102.4a Assessment	Controls specified for replacement will be confirmed Existing controls to be retained will be confirmed as installed correctly Current settings will be documented	Document status of existing controls		6240
5.3102.4b Repair	Existing installation will be corrected if settings do not match specified scope of work	Ensure boiler operates at optimal water temperatures Reduce short cycling		6241
5.3102.4c Replacement of aquastat	Existing controls will be removed New control will be visible and installed in an accessible location for adjustments in accordance with manufacturer specifications New control will be set to temperature settings stated on scope of work	Ensure boiler operates at optimal water temperatures Reduce short cycling		6242
5.3102.4d Testing	Temperature and pressure gauges will be checked for accuracy Contractor will observe and confirm boiler operation over a minimum of three cycles Safety control will be tested to ensure the burner shuts off at high limit	Ensure proper installation Ensure proper and safe operation		6243
5.3102.4e Education	Property manager will be educated on the operation and purpose of controls and settings	Ensure proper use of controls Maintain optimal temperature settings		6244

5.3102.5 Installation of Outdoor Reset Boiler Controller (Hot Water)

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Installation

Desired Outcome: Varied distribution loop temperatures match seasonal heating load

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3102.5a Determine location of outdoor sensor	Optimal outdoor sensor location will be determined by visual inspection of building exterior (e.g., north facing, shaded, away from heat sources and exhaust outlets, exposed to typical wind conditions, and in a secure location)	Determine optimal location for outdoor sensor		6245
5.3102.5b Determine location of distribution piping sensor	Presence of integral outdoor reset control in boiler control panel will be determined. Indoor sensor will be located on distribution supply header	Determine optimal location for indoor sensor		6246
5.3102.5c Check for presence of asbestos-containing materials (ACMs)	Potential ACMs will be handled in accordance with SWS 2.0110.2 Potential Asbestos-Containing Materials	Ensure a safe work environment		6247
5.3102.5d Install sensors	Outdoor sensor will be installed in optimal location in accordance with manufacturer specifications As necessary, indoor sensor will be installed on distribution supply header in accordance with manufacturer specifications Presence and function of thermometers on supply and return headers will be verified; thermometers will be installed or replaced as necessary Strap-on indoor sensors will be connected tightly to piping; piping and sensor will be reinsulated with new insulation to IECC and ASHRAE 90.1, at a minimum Immersion-type sensors will be provided with heat transfer grease between sensor and thermowell in	Properly install sensors in optimal locations		6248

	accordance with manufacturer's instructions			
5.3102.5e Mount control panel	Control panels that are not part of the boiler will be mounted and wired in accordance with manufacturer specifications and protected from tampering by unauthorized personnel	Ensure proper code-compliant installation of control panel		6249
5.3102.5f Connect sensors	Sensors will be connected with wiring in accordance with manufacturer specifications and protected from friction and abrasion as they pass through building components	Properly connect sensors		6250
5.3102.5g Set up control panel	Control optimization will be followed in accordance with SWS 5.3104.4 Optimize Outdoor Reset Boiler Controller (Hot Water)	Optimize control		6251

5.3102.6 Installation of Outdoor Reset Valve and Controller (Hot Water)

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Installation

Desired Outcome: Varied distribution loop temperatures match seasonal heating load

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3102.6a Check for presence of asbestos-containing materials (ACMs)	Potential ACMs will be handled in accordance with SWS 2.0110.2 Potential Asbestos-Containing Materials	Ensure a safe work environment		6252
5.3102.6b Isolate reset valve location	Nearest valves on either side of valve location will be closed	Eliminate water supply to the valve location		6253
5.3102.6c Install reset valve and associated piping	Reset valve and associated piping will be installed between distribution supply and return headers in accordance with valve and boiler manufacturer specifications System will be refilled and air will be eliminated	Allow distribution loop flow to the bypass boiler		6254
5.3102.6d Reinsulate area	Where insulation was removed, valve and associated piping will be reinsulated with new insulation to	Reduce energy loss Maintain safe surface temperature		6255

	IECC and ASHRAE 90.1, at a minimum			
5.3102.6e Determine location of outdoor sensor	Optimal outdoor location (e.g., north facing, shaded, away from heat sources and exhaust outlets, exposed to typical wind conditions, and in a secure location) will be determined by visual inspection of building exterior	Determine optimal location for outdoor sensor		6256
5.3102.6f Install sensors	Hot water supply sensor will be located on distribution supply header downstream of reset valve Outdoor sensor will be installed in optimal location in accordance with manufacturer specifications Presence and function of thermometers on supply and return headers will be verified; thermometers will be installed or replaced as necessary Strap-on piping temperature sensors will be connected tightly to piping; piping and sensor reinsulated with new insulation in accordance with IECC and ASHRAE 90.1, at a minimum Immersion-type sensors will be provided with heat transfer grease between sensor and thermowell in accordance with manufacturer specifications	Properly install sensors in optimal locations		6257
5.3102.6g Mount control panel	Control panel will be mounted and wired in accordance with manufacturer specifications and protected from tampering by unauthorized personnel	Ensure proper code-compliant installation of control panel		6258
5.3102.6h Connect sensors and valve	Sensors and valve will be connected with wiring in accordance with manufacturer specifications and protected from friction and abrasion as it passes through building components	Properly connect sensors and valve		6259
5.3102.6i Set up control panel	Control optimization will be followed in accordance with SWS 5.3104.5 Optimize Outdoor Reset Valve Controller (Hot Water)	Ensure optimization of control		6260

5.3102.7 Installation of Lead-Lag Controls—Pumps (Hot Water)

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Installation

Desired Outcome: Automated redundant pump operation provides consistent heat to building

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3102.7a Check for presence of asbestos-containing materials (ACMs)	Potential ACMs will be handled in accordance with SWS 2.0110.2 Potential Asbestos-Containing Materials	Ensure a safe work environment		6261
5.3102.7b Verify presence of check valves	Presence and condition of check valves will be verified; if needed, refer to SWS 5.3103.3 Check Valves (Hot Water), for installation specifications	Ensure water flow does not bypass through nonoperating pumps		6262
5.3102.7c Verify pump motor controller is suitable for automated control	Presence of automatic control input on motor controller will be verified; if needed, add electrical components corresponding to pump motor size	Prepare motor control circuit for automatic control		6263
5.3102.7d Install lead lag control panel	Lead-lag control panel will be mounted and wired in accordance with manufacturer specifications Pump lead-lag controller will be wired to boiler/boiler lead-lag control panel and programmed/interlocked as necessary	Provide automated control of pumping integrated with boiler system		6264
5.3102.7e Test complete system	Successful operation of pumps will be demonstrated	Ensure pumps are controlled by automated controller		6265
5.3102.7f Education	Completed work will be reviewed with the building/property management team and operations staff Building/property management team and operations staff will be educated on the safe and efficient operation and maintenance requirements of the installed item	Ensure building/property management team and operations staff is informed of the safe, efficient operation and maintenance requirements of the installed item		6266

5.3102.8 Replacement of Conventional Pumps with Electrically Commutated Motor-Driven Pumps (Hot Water)

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Installation

Desired Outcome: Improved pump efficiency and control

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3102.8a Check for presence of asbestos-containing materials (ACMs)	Potential ACMs will be handled in accordance with SWS 2.0110.2 Potential Asbestos-Containing Materials	Ensure a safe work environment		6267
5.3102.8b Isolate pump location	Nearest valves on either side of pump location will be closed Power supply will be disconnected	Eliminate water and power supply to the pump location		6268
5.3102.8c Replace pump with electrically commutated motor (ECM) pump	Existing pump will be removed and replaced with ECM pump, installed in accordance with manufacturer specifications Gauges will be installed on inlet and outlet sides of pump location System will be refilled, and air will be eliminated Power will be restored to new ECM pump Pump speed variation will be verified by exercising some valves in the system, simulating load demand changes	Ensure proper operation of ECM pump		6269
5.3102.8d Reinsulate area	Where insulation was removed, valve will be reinsulated with new insulation to IECC and ASHRAE 90.1, at a minimum	Reduce energy loss Maintain safe surface temperature		6270
5.3102.8e Educate building operations staff	Building operations staff will be educated to operate ECM pump	Ensure continued optimized performance		6271

5.3102.9 Installation and Control of Variable Frequency Drives (Hot Water)

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Installation

Desired Outcome: Electrical consumption reduced while matching water flow to demand

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3102.9a Evaluate existing pumps and motors	Motors will be evaluated to determine compatibility with variable frequency drives (VFD) Load profile and source equipment will be analyzed for use of VFD to provide variable water flow to load System valves will be surveyed to identify two-way and three-way valve locations Control strategy will be determined (e.g., differential pressure control, pressure control, differential temperature control, summer/winter settings)	Ensure existing motors and system are compatible with VFD operation		6272
5.3102.9b Remove and replace motor	If removal and replacement of motor is required, the power supply will be disconnected, and the existing motor will be removed and replaced with motor suitable for VFD operation	Provide motor suitable for VFD operation		6273
5.3102.9c Remove and replace motor starter	Power supply will be disconnected; existing starter will be replaced with VFD in accordance with manufacturer specifications	Install and connect VFD		6274
5.3102.9d Install required sensors	Implement the following VFD control strategies: • Feedback sensors will be installed in accordance with manufacturer specifications at locations that will optimize chosen control strategy • Feedback sensors will be wired to VFD in accordance with manufacturer specifications	Ensure sensors are installed to optimize VFD operation		6275
5.3102.9e Modify system to VFD control	System will be modified to best utilize VFD operation (e.g., conversion of three-way valves to two-way valves), as well as to safely operate boiler	Ensure system is compatible with VFD operation		6276
5.3102.9f Restore power supply to VFD, and verify operation	Power supply will be restored VFD will be shown to be capable of operating pump VFD will be shown to be capable of receiving sensor signals	Ensure VFD is ready for setup		6277

of VFD and pump				
5.3102.9g Initial setup of VFD	VFD parameters will be set up to accept feedback from sensors, dependent upon chosen control strategy	Maintain minimum system heating requirements with reduced electrical energy use		6278
5.3102.9h Educate building operations staff	Building operations staff will be educated to operate VFD systems, including sensor location, control operation, and set points	Ensure continued optimized performance		6279

5.3103.1 Balancing Valve Installation

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Piping (Distribution Installation)

Desired Outcome: Desired flow provided to system devices

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3103.1a Check for presence of asbestos-containing materials (ACMs)	Potential ACMs will be handled in accordance with SWS 2.0110.2 Potential Asbestos-Containing Materials	Ensure a safe work environment		6448
5.3103.1b Determine locations for balancing valves	Prior to installation of balancing devices, the distribution will be cleaned of any debris that can clog the new devices Available plans will be reviewed to assess system design and intent Balancing valve location and condition will be visually verified; valves should be located on all distribution loops and critical flow dependent devices (e.g., boilers, air handlers, heat exchangers, fan coils, etc.)	Determine current configuration		6449
5.3103.1c Evaluate balancing options	Use of automatic vs. manual balancing valves will be evaluated in terms of life cycle cost (installation labor, hardware, labor to balance, and impact on energy consumption)	Determine a balancing strategy that ensures balancing throughout peak heating and shoulder seasons		6450
5.3103.1d Isolate	Nearest valves on either side of valve location will be closed	Eliminate water supply to valve location		6451

balance valve location				
5.3103.1e Repair and/or install balance valve	Functionality of balance valve will be assessed and repaired/replaced if necessary New balance valves will be installed on all distribution loops and critical flow dependent devices (e.g., boilers, air handlers, heat exchangers, fan coils) System will be refilled and air will be eliminated	Install valves in appropriate locations		6452
5.3103.1f Set balance valve	Valve will be adjusted to match device specification Water flow will be measured in accordance with ANSI/ACCA Standard 5 or ANSI/ASHRAE Standard 111 and adjusted to meet design requirements	Ensure proper flow through device		6453
5.3103.1g Reinsulate area	Where insulation was removed, valve will be reinsulated with new insulation to IECC and ASHRAE 90.1, at a minimum	Reduce energy loss Maintain safe surface temperature		6454
5.3103.1h Education	Completed work will be reviewed with the building/property management team and operations staff Building/property management team and operations staff will be educated on the safe and efficient operation and maintenance requirements of the installed item	Ensure building/property management team and operations staff is informed of the safe, efficient operation and maintenance requirements of the installed item		6455

5.3103.10 Convert Two-Pipe Steam to Hot Water

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Piping (Distribution Installation)

Desired Outcome: Improved efficiency of heating system

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3103.10a Check for presence of asbestos-containing materials (ACMs)	Potential ACMs will be handled in accordance with SWS 2.0110.2 Potential Asbestos-Containing Materials	Ensure a safe work environment		6498

5.3103.10b Assessment	System schematics, manufacturer specifications, and physical locations for all new components will be reviewed to identify proper and serviceable locations Existing distribution piping system and retained components will be hydrostatically (or pressure) tested after traps on distribution piping and air vent opening on radiators have been capped and/or plugged If new boiler will be used for domestic hot water (DHW) generation, boiler manufacturer specifications will be reviewed for need of buffer tank; if required, buffer tank will be sized and installed in accordance with SWS 5.3188.2 Adding Mass to Low Mass Boiler - Existing or New	Ensure system is capable of conversion		6499
5.3103.10c Installation of devices and piping components	Sections of piping and fittings that failed hydrostatic test will be replaced with properly sized pipe and piping material. Ensure the replacement piping meets the necessary strength requirements Dielectric joints will be used to connect two dissimilar materials Pipes will be properly secured (hanged or supported from below) Pumps and/or zone valves, air separator, expansion tank, strainers, riser balance valves, and associated valves and fittings will be installed in accordance with applicable standard work specifications , Thermometers, pressure gauges, and isolation valves will be installed in accordance with applicable standard work specifications: SWS 5. 3102.31 Installation of Thermometers (Includes Hot Water), SWS 5.3102.21 Steam Boiler Pressure Operating Controls (Steam), SWS 5.3103.6 Two Pipe Steam Systems - Steam Traps, SWS 5.3103.7 Instatllion of Pressure Gauges If applicable, DHW heater will be installed in accordance with specifications based on applicable water type	Safely and properly install piping, control components, and DHW heater, if applicable		6500

5.3103.10d Installation of controls	Outdoor reset controls will be installed in accordance with applicable standard work specifications: SWS 5.3102.5 Installation of Outdoor Reset Boiler Controller (Hot Water), SWS 5.3103.6 Two Pipe Steam Systems - Steam Traps Pumps/zone valves (and domestic hot water heater sensors/aquastats, if applicable) will be connected to boiler/boiler sequencing controls in accordance with applicable standard work specifications If applicable, DHW prioritization will be verified	Ensure generation of heat and, if applicable, domestic hot water with domestic hot water prioritization		6501
5.3103.10e Hydrostatic testing and flushing	System will be hydrostatically tested to withstand operating system pressure; system components will be repaired/replaced as necessary System will be drained and flushed	Ensure the system is free of leaks, debris, and foreign objects		6502
5.3103.10f Insulate modified system components	All devices requiring service will be insulated with removable and reusable insulation to IECC and ASHRAE 90.1, at a minimum All piping and fittings will be insulated with fixed insulation to IECC 2012 and ASHRAE 90.1-2010, at a minimum	Reduce energy loss Maintain safe surface temperature		6503
5.3103.10g System testing and verification	Hot water production, distribution system, and delivery temperature will be tested for proper and safe operation If applicable, DHW generation will be tested with domestic water prioritization	Ensure system is operating safely and efficiently		6504
5.3103.10h Optimization	System will be optimized in accordance with SWS 5.3104.4 Hot Water Operating Controls - Aquastat (Hot Water)	Optimize system efficiency		6505
5.3103.10i Education	Completed work will be reviewed with the building/property management team and operations staff Building/property management team and operations staff will be educated on the safe and efficient operation and maintenance requirements of the installed item	Ensure building/property management team and operations staff is informed of the safe, efficient operation and maintenance requirements of the installed item		6506

5.3103.11 Replacement of Tankless Coil for Domestic Hot Water Production

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Piping (Distribution Installation)

Desired Outcome: Safe and efficient supply of domestic hot water

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3103.11a Coil assessment	Assessment will be conducted to determine whether alternative options for providing domestic hot water exist, such as: • Separate direct-fired unit (SWS 7.8102.4 Storage Tank-Type Water Heater) • Boiler with indirect water heater (SWS 5.3102.10 Installation of Combined Heat and Domestic Hot Water System (Hot Water)) Selected coil size will be verified for appropriate capacity by a contractor	Ensure optimal system is applied Ensure domestic hot water load is met		6507
5.3103.11b Coil replacement	Selected coil will be of a higher efficiency/effectiveness Contractor to ensure new coil passes pressure test before installation Isolation valves will be installed for proper servicing DHW mixing valve will be installed on the discharge side of the coil to regulate DHW supply water temperature Gauges and insulation of associated piping will be installed and functioning	Increase efficiency Ensure supply of safe domestic hot water by eliminating cross contamination Ensure ease of access, operation and maintenance		6508
5.3103.11c Testing	DHW production, distribution system, and delivery temperature will be tested for proper and safe operation	Ensure system operates safely and efficiently		6509
5.3103.11d Control recalibration	If alternative, stand-alone DHW production system is selected, burner controls will be adjusted to address remaining heating load	Ensure heating system is optimized		6510
5.3103.11e Education	Property manager will be educated on proper operation and maintenance of tankless coil	Maintain optimal performance		6511

5.3103.2 Air Elimination (Hot Water)

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Piping (Distribution Installation)

Desired Outcome: No air in water distribution system

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3103.2a Check for presence of asbestos-containing materials (ACMs)	Potential ACMs will be handled in accordance with SWS 2.0110.2 Potential Asbestos-Containing Materials	Ensure a safe work environment		6456
5.3103.2b Locate air separators and automatic air vents	Location of air separators and air vents will be determined	Determine location of mechanical room air vents and system high point air vents		6457
5.3103.2c Isolate and replace faulty automatic air vents	Nearest valves on either side of air vent location will be closed Air vents will be replaced New air vents will be considered for locations such as inverted Us and at the top of risers System will be refilled and air will be eliminated	Eliminate water supply to air vent location Vent air from system		6458
5.3103.2d Isolate and install air separator	Nearest valves on either side of air separator location will be closed Air separator will be installed at optimal system location in accordance with manufacturer specifications System will be refilled and air will be eliminated	Eliminate water supply to air separator location Vent air from system		6459
5.3103.2e Reinsulate area	Where insulation was removed, valve will be reinsulated with new insulation to IECC and ASHRAE 90.1, at a minimum	Reduce energy loss Maintain safe surface temperature		6460
5.3103.2f Education	Completed work will be reviewed with the building/property management team and operations staff Building/property management team and operations staff will be educated on the safe and efficient operation and maintenance requirements of the installed item	Ensure building/property management team and operations staff is informed of the safe, efficient operation and maintenance requirements of the installed item		6461

5.3103.3 Check Valves (Hot Water)

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Piping (Distribution Installation)

Desired Outcome: Specified water flow provided to system

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3103.3a Check for presence of asbestos-containing materials (ACMs)	Potential ACMs will be handled in accordance with SWS 2.0110.2 Potential Asbestos-Containing Materials	Ensure a safe work environment		6462
5.3103.3b Isolate check valve location	Nearest valves on either side of valve location will be closed	Eliminate water supply to valve location		6463
5.3103.3c Install check valves	Check valves will be installed on all pump discharges into common headers System will be refilled and air will be eliminated	Ensure water flow does not bypass through nonoperating pumps		6464
5.3103.3d Reinsulate area	Valve will be reinsulated with new insulation to IECC and ASHRAE 90.1, at a minimum	Reduce energy loss Maintain safe surface temperature		6465

5.3103.4 Distribution Load Balancing

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Piping (Distribution Installation)

Desired Outcome: Even heating distribution

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3103.4a Evaluate balancing options	Use of automatic or manual balancing valves will be evaluated in terms of life cycle cost (installation labor, hardware, labor to balance, and impact on energy consumption)	Determine a balancing strategy that ensures balance throughout peak heating and shoulder seasons		6466
5.3103.4b Check for presence of asbestos-containing materials (ACMs)	Potential ACMs will be handled in accordance with SWS 2.0110.2 Potential Asbestos-Containing Materials	Ensure a safe work environment		6467

5.3103.4c Installing balancing devices	Prior to installation of balancing devices, the distribution will be cleaned of any debris that can clog the new devices Balancing devices in building will be repaired or replaced by a contractor to ensure a balanced system Flow direction will be checked to ensure proper orientation of balancing device System will be refilled and air will be eliminated	Ensure even heating distribution during peak and shoulder months		6468
5.3103.4d Testing and verification	Contractor will confirm performance to manufacturer specifications Water flow will be measured in accordance with ANSI/ACCA Standard 5 or ANSI/ASHRAE Standard 111 and adjusted to meet design requirements	Ensure system operates safely and efficiently		6469
5.3103.4e Reinsulate area	Where insulation was removed, valve will be reinsulated with new insulation to IECC and ASHRAE 90.1, at a minimum	Reduce energy loss Maintain safe surface temperature		6470
5.3103.4f Education	Completed work will be reviewed with the building/property management team and operations staff Building/property management team and operations staff will be educated on the safe and efficient operation and maintenance requirements of the installed item	Ensure building/property management team and operations staff is informed of the safe, efficient operation and maintenance requirements of the installed item		6471

5.3103.5 One-Pipe Steam System—Steam Air Vents

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Piping (Distribution Installation)

Desired Outcome: Optimized steam system for even and rapid distribution

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3103.5a Check for presence of asbestos-containing materials (ACMs)	Potential ACMs will be handled in accordance with SWS 2.0110.2 Potential Asbestos-Containing Materials	Ensure a safe work environment		6472

5.3103.5b Optimize system	Contractor will repair or replace steam air vents in building to ensure the system responds quickly and evenly Proper pitch of radiator will be verified by a contractor	Ensure even heating distribution during peak and shoulder months		6473
5.3103.5c Steam main air vents	Air vents will be installed at end of steam mains Number of vents required will be determined based on volume of air that needs to be displaced Air vents will be installed minimum 15" from the end to minimize damage Air vents will be installed on 6"–10" nipple from top of the steam piping Air vents will be installed on vertical risers, 4"–6" below the top end	Ensure balanced heat distribution		6474
5.3103.5d Radiator air vents	Air vent size (venting capacity) will be determined by location of the terminal unit within distribution system and size of the terminal unit Air vent will be installed in upright position	Discharge air for proper steam distribution		6475
5.3103.5e Education	Completed work will be reviewed with the building/property management team and operations staff Building/property management team and operations staff will be educated on the safe and efficient operation and maintenance requirements of the installed item	Ensure building/property management team and operations staff is informed of the safe, efficient operation and maintenance requirements of the installed item		6476

5.3103.6 Two-Pipe Stream System—Steam Traps

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Piping (Distribution Installation)

Desired Outcome: Properly functioning radiators

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3103.6a Conduct trap inventory and testing	Location and type of traps will be determined and documented for future use Trap operation and condition will be determined using methods that include temperature difference between inlet/outlet, infrared camera, sound, and observation of flooded cold	Identify nonfunctioning traps		6477

	radiators and condensate temperature at the condensate/boiler feed tank			
5.3103.6b Replace or repair traps as necessary	Nearest valves on either side of steam trap location will be closed Trap bodies will be disassembled and thermostatic element replaced or new trap will be installed Replacement steam trap will be properly sized to match load requirements, not the pipe size Replacement steam trap will be of proper pressure rating Install strainers before traps on the steam mains	Ensure properly functioning steam traps		6478
5.3103.6c Education	Completed work will be reviewed with the building/property management team and operations staff Building/property management team and operations staff will be educated on the safe and efficient operation and maintenance requirements of the installed item	Ensure building/property management team and operations staff is informed of the safe, efficient operation and maintenance requirements of the installed item		6479

5.3103.7 Installation of Pressure Gauges

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Piping (Distribution Installation)

Desired Outcome: Accurate verification of system operating conditions

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3103.7a Check for presence of asbestos-containing materials (ACMs)	Potential ACMs will be handled in accordance with SWS 2.0110.2 Potential Asbestos-Containing Materials	Ensure a safe work environment		6480
5.3103.7b Location of pressure gauges	Available plans will be reviewed to assess system design and intent Pressure gauge locations and conditions will be visually verified; pressure gauges should be located on the inlet and outlet of all flow dependent devices (e.g., boilers, pumps, strainers, heat exchangers, coils, control valves)	Determine minimum pressure gauge placement		6481

5.3103.7c Select appropriate pressure gauges	Pressure gauge range will be selected to ensure accurate readings over system operating range For high-rise applications where pressure differential is a small percentage of gauge pressure range, differential pressure gauges will be used	Ensure selected pressure gauge provides accurate pressure measurement		6482
5.3103.7d Install pressure gauge	Nearest valves on either side of pressure gauge location will be closed Pressure gauge will be installed in accordance with manufacturer specifications Measurement accuracy of differential pressure applications (e.g., pumps, strainers, heat exchangers, valves) will be improved when a single-pressure gauge is connected to both inlet and outlet of device with appropriate valving System will be refilled and air will be eliminated	Properly install pressure gauge		6483
5.3103.7e Reinsulate area	Where insulation was removed, gauge tapping and associated piping will be reinsulated with new insulation to IECC and ASHRAE 90.1, at a minimum	Reduce energy loss Maintain safe surface temperature		6484
5.3103.7f Education	Completed work will be reviewed with the building/property management team and operations staff Building/property management team and operations staff will be educated on the safe and efficient operation and maintenance requirements of the installed item	Ensure building/property management team and operations staff is informed of the safe, efficient operation and maintenance requirements of the installed item		6485

5.3103.8 Isolation Valve Installation

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Piping (Distribution Installation)

Desired Outcome: Facilitation of service or replacement of equipment

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3103.8a Check for	Potential ACMs will be handled in accordance with SWS 2.0110.2	Ensure a safe work environment		6486

presence of asbestos-containing materials (ACMs)	Potential Asbestos-Containing Materials			
5.3103.8b Work site preparation	Nearest valves on either side of new valve location will be closed Fluid in the system will be drained to safe and appropriate location	Eliminate fluid supply to valve location		6487
5.3103.8c Install isolation valve	Isolation valves will be installed on risers and distribution loops to permit maintenance or replacement of equipment, such as pumps, boilers, control valves, strainers, etc.	Provide means of servicing system and equipment		6488
5.3103.8d Testing and verification	System will be checked for leakage System will be refilled and air will be eliminated	Ensure there are no leaks in the system and that the valve is operating		6489
5.3103.8e Reinsulate area	Where insulation was removed, valve will be reinsulated with new insulation to IECC and ASHRAE 90.1, at a minimum	Reduce energy loss Maintain safe surface temperature		6490
5.3103.8f Education	Completed work will be reviewed with the building/property management team and operations staff Building/property management team and operations staff will be educated on the safe and efficient operation and maintenance requirements of the installed item	Ensure building/property management team and operations staff is informed of the safe, efficient operation and maintenance requirements of the installed item		6491

5.3103.9 Installation of Strainers

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Piping (Distribution Installation)

Desired Outcome: Critical mechanical equipment protected from sediment, debris, and foreign objects within the system

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3103.9a Check for presence of asbestos-containing materials (ACMs)	Potential ACMs will be handled in accordance with SWS 2.0110.2 Potential Asbestos-Containing Materials	Ensure a safe work environment		6492

5.3103.9b Isolate strainer location	Nearest valves on either side of strainer location will be closed	Eliminate water supply to the strainer location		6493
5.3103.9c Install strainer	Strainer will be installed in accordance with manufacturer specifications; locations may include the inlet side of pumps, heat exchangers, coils, and boilers Strainer orientation will allow sufficient clearance for filter/strainer basket removal System will be refilled and air will be eliminated	Prevent sediment, debris, and foreign object entry into pumps, heat exchangers, coils, or boilers		6494
5.3103.9d Remove temporary strainer screen	Temporary strainer screen will be removed and inspected during initial system startup Temporary strainer screen will be cleaned, reinstalled, and periodically monitored until screen is shown to be free of debris; after which, temporary screen will be removed	Ensure strainer is free of startup debris		6495
5.3103.9e Reinsulate area	Where insulation was removed, strainer will be reinsulated with removable insulation to IECC and ASHRAE 90.1, at a minimum	Reduce energy loss Maintain safe surface temperature		6496
5.3103.9f Education	Completed work will be reviewed with the building/property management team and operations staff Building/property management team and operations staff will be educated on the safe and efficient operation and maintenance requirements of the installed item	Ensure building/property management team and operations staff is informed of the safe, efficient operation and maintenance requirements of the installed item		6497

5.3104.10 Gas Boiler—Service Inspection

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Maintenance, Testing, and Repair

Desired Outcome: Boiler service improves safety, efficiency, and performance

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3104.10a Health and safety	In applicable cases, such as in-unit installs, the BPI protocol for combustion appliance zone	Identify potential health and safety issues		6557

	combustion safety testing will be administered			
5.3104.10b Visual inspection	Inspections will be made based on ANSI/ASHRAE/ACCA Standard 180 Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems for commercial applications and ANSI/ACCA 4 Maintenance of Residential HVAC Systems for residential applications Examples of items to be addressed are as follows: • Water, steam, and fuel leaks • Damaged or missing pipe insulation • Draft and condensation venting issues (e.g., soot, rusting of flue pipe, burned paint or wires, efflorescence) • Corrosion (e.g., rust, mineral deposits) • General condition of components	Observe general conditions to determine needed repairs or maintenance		6558
5.3104.10c Gas valves	Gas pressure will be checked to make sure it is in compliance with manufacturer requirements Gas valves will be checked to ensure they are operating in accordance with manufacturer specifications If gas valve is found to be not working as required by the manufacturer requirements, recommendations will be made for necessary repairs/replacement New gas valve will be installed in accordance with manufacturer specifications	Provide gas to burner when there is a call for heat Control volume of gas for burner Ensure the safe shut off of gas once heat is turned off		6559
5.3104.10d Ignition system	Components of ignition system will be repaired or replaced in accordance with manufacturer specifications	Do not allow the flow of the main burner gas without proof of ignition		6560
5.3104.10e Main gas burners	Problems that may interfere with flame (e.g., dust, debris, misalignment) will be cleaned, vacuumed, and adjusted	Produce combustion in a safe, clean, and efficient manner		6561
5.3104.10f Low water cutoff and blow-down systems	Low water cutoff and blow-down systems shall be checked to be properly operating and in compliance with manufacturer requirements	Ensure the safety and durability of cutoff and blow-down systems		6562

5.3104.10g Venting	The venting system will be maintained in accordance with applicable codes and manufacturer's instructions	Ensure the safety and durability of the venting system		6563
5.3104.10h Combustion testing	Undiluted flue gases will be checked with a calibrated flue gas analyzer in accordance with accepted protocol (e.g., BPI, NATE) If combustion is not occurring safely or with maximum efficiency, diagnostics and adjustments will be done in accordance with manufacturer specifications or local codes	Confirm that combustion occurs safely with maximum efficiency		6564
5.3104.10i Occupant health	All occupied units in a building with combustion appliances will have a carbon monoxide (CO) monitor, in accordance with local code requirements or NFPA Ambient CO levels will be maintained under code-acceptable thresholds	Ensure ambient CO does not exceed acceptable levels after completion of work		6565
5.3104.10j Education	Building/property management team and operations staff and occupants will be educated on the operation and battery maintenance of the CO monitor Building/property management team and operations staff and occupants will be educated about unsafe limits and actions to take should unsafe conditions occur Completed work and recommended maintenance will be reviewed with building/property management team and operations staff and occupants	Ensure occupant is informed of the safe and efficient operation and maintenance of the work performed		6566

5.3104.11 Leak Detection and Repair—Fuel Piping

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Maintenance, Testing, and Repair

Desired Outcome: System does not leak.

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3104.11a Check for presence of asbestos-	Potential ACMs will be handled in accordance with SWS 2.0110.2 Potential Asbestos-Containing Materials	Ensure a safe work environment		6567

containing materials (ACMs)				
5.3104.11b Assessment	Fuel oil leaks will be detected through visual inspection of piping system Gas leaks will be detected through use of properly calibrated combustion gas detector or bubble test of piping system	Determine leak location		6568
5.3104.11c Repair fuel leak	Nearest valves on either side of leak location will be closed Piping, fitting, or device will be repaired or replaced	Ensure fuel piping system does not leak		6569
5.3104.11d Confirm system is leak free	Isolated section will be reconnected to fuel supply Fuel oil leaks will be detected through visual inspection of piping system Gas leaks will be detected through use of properly calibrated combustion gas detector or bubble test of piping system	Confirm system is safe for operation		6570
5.3104.11e Clean fuel oil leak	Fuel oil leaks will be cleaned and materials will be disposed of in accordance with local codes Oily rags and paper used to clean up the spill shall be placed in an approved safety container until properly disposed Outdoor oil spills will be reported in accordance with local codes and jurisdictions	Remove hazardous materials		6571
5.3104.11f Reinsulate area	Where insulation was removed, repaired pipe, fitting, or device will be reinsulated with new insulation to IECC , and ASHRAE 90.1, at a minimum	Reduce energy loss Maintain safe surface temperature		6572

5.3104.12 Leak Detection and Repair—Distribution Leaks

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Maintenance, Testing, and Repair

Desired Outcome: System does not leak

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)	

5.3104.12a Check for presence of asbestos-containing materials (ACMs)	Potential ACMs will be handled in accordance with SWS 2.0110.2 Potential Asbestos-Containing Materials	Ensure a safe work environment		6573
5.3104.12b Assessment	Leaks will be detected through visual inspection of piping and insulation system Damaged insulation will be removed and properly disposed of	Determine leak location		6574
5.3104.12c Repair leak	Nearest valves on either side of leak location will be closed Water/condensate from isolated section will be drained to safe and appropriate location Piping, fitting, or device will be repaired or replaced	Eliminate water or steam supply to leak location Ensure distribution system does not leak		6575
5.3014.12d Testing and verification	Isolated section will be reconnected and repressurized System will be filled and air will be eliminated from system Repaired pipe, fitting, or device will be visually inspected	Confirm system is safe for operation		6576
5.3104.12e Reinsulate area	Where insulation was removed, repaired pipe, fitting, or device will be reinsulated with new insulation to IECC and ASHRAE 90.1, at a minimum	Reduce energy loss Maintain safe surface temperature		6577
5.3104.12f Dry or restore building materials saturated by leak	Damaged materials will be removed, and replaced in a safe manner and in accordance with all applicable codes Bulk moisture will be eliminated	Prevent an environment for biological growth Create clean, dry surface for insulation installation		6578

5.3104.13 Leak Detection and Repair—Direct Vent Boiler Exhaust

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Maintenance, Testing, and Repair

Desired Outcome: Direct vent boiler exhaust system does not leak

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3104.13a Check for presence of	Potential ACMs will be handled in accordance with SWS 2.0110.2	Ensure a safe work environment		6579

asbestos-containing materials (ACMs)	Potential Asbestos-Containing Materials			
5.3104.13b Identify leak location	Exhaust leaks will be located through visual inspection of exhaust system (signs of leak may include dripping water, misaligned joints, evidence of air movement, discoloration of adjoining surfaces) If visual inspection does not reveal exhaust leak, leak will be located through instrumented inspection with use of properly calibrated combustion gas detector or smoke test of exhaust system	Determine leak location		6580
5.3104.13c Turn off combustion system	Combustion system will be turned off to stop exhaust vent system leak	Eliminate exhaust release		6581
5.3104.13d Repair leak	Piping, fitting, or device will be repaired or replaced	Ensure exhaust system does not leak		6582
5.3104.13e Restart combustion system	Combustion system will be restarted and integrity of repair assessed with a properly calibrated combustion gas detector	Confirm system is safe for operation		6583
5.3104.13f Education	Completed work will be reviewed with the building/property management team and operations staff Building/property management team and operations staff will be educated on the safe and efficient operation and maintenance requirements of the installed item	Ensure building/property management team and operations staff is informed of the safe, efficient operation and maintenance requirements of the installed item		6584

5.3104.14 Tuneup and Upgrades

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Maintenance, Testing, and Repair

Desired Outcome: Optimized efficiency of existing system

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3104.14a Safety of equipment	A safety assessment will be conducted to identify the following conditions: • Fuel leak • Flue/exhaust leaks	Ensure occupant and mechanic safety		6585

	• Carbon monoxide • Electrical hazards • Water and steam leaks Any hazardous conditions will be addressed before tuneup and work Property manager and occupant will be notified of all hazardous conditions and confirm action plan			
5.3104.14b Assessment	A review of site conditions and verification of work order will be done	Confirm feasibility of the scope of work		6586
5.3104.14c Minimize standby loss	Presence and operation of the following will be checked: • Flue/vent dampers • Modulating draft controls • Insulation • Electronic ignition • Combustion air dampers • Combustion air intake fan If not present or in scope of work, above upgrades will be considered Short cycling will be eliminated	Maximize the seasonal efficiency of boiler Identify opportunities for upgrades		6587
5.3104.14d Combustion efficiency improvement	Undiluted flue gases will be checked with a calibrated flue gas analyzer in accordance with accepted protocol If combustion is not occurring safely or with maximum efficiency, diagnostics and adjustments will be done in accordance with work order specifications, which may include the following: • Clean fire side/heat exchanger • Clean water side • Burner elements • Proper fuel delivery • Modulating draft controls Fuel/air ratio will be adjusted to meet specified performance over a range of firing rates, when applicable	Confirm that combustion occurs safely with maximum efficiency		6588
5.3103.14e Education	Completed work will be reviewed with the building/property management team and operations staff Building/property management team and operations staff will be educated on the safe and efficient operation and maintenance requirements of the installed item	Ensure building/property management team and operations staff is informed of the safe, efficient operation and maintenance requirements of the installed item		6589

5.3104.15 Controls—Underground Leak Detection

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Maintenance, Testing, and Repair

Desired Outcome: Monitor underground leaks for quick corrective actions

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3104.15a Hazardous materials	Materials containing asbestos will be dealt with in accordance with SWS 2.0110.2 Potential Asbestos-Containing Materials Hazardous materials will be handled in accordance with applicable local laws and codes before work begins	Ensure safe environment and work place		6590
5.3104.15b Installation of underground leak detection system	If steam piping is insulated, assess for presence of asbestos-containing materials (ACMs) prior to disturbing the material; if confirmed not to be an ACM, then proceed with the following: • Insulation will be removed from the piping where monitoring sensors or gauges will be installed • Control sensors or gauges will be installed no more than 5' upstream and downstream of point of pipe entry and exit into and out of the ground, respectively • Control sensors and gauges will be installed with anti-siphon piping with pet cocks • Control sensor will be wired back to controller • Wiring will be in accordance with manufacturer specifications and all applicable codes • Pressure gauges will be installed such that the display face plate is facing in the direction that is easy to read without need of ladder • Service valves will be installed for isolation and ease of maintenance, repair, and replacement of control sensor or gauges	Ensure the control sensors or pressure gauges are installed to allow leak monitoring		6591

	• Drain valves will be installed between the isolation valves to drain the left over medium during repairs and maintenance			
5.3104.15c Testing and verification	A pressure differential (Δp) chart will be established at various load conditions, which will be used as benchmark to monitor leak A complete installation and operation and maintenance manual will be provided to the property manager/occupant	Confirm system capabilities and functionalities		6592
5.3104.15d Education	Building/property management team and building operations staff will be trained on use of control or gauges to monitor leak and regular maintenance procedure Multiple laminated copies of the pressure differential chart will be provided to building/property management team for filing and posting near sensor and gauge installation location Protocols will be set for someone from the building operations staff to record the readings on a regular basis, and the management staff to review and file the logs Management will call for corrective actions as soon as problem is identified	Educate client on best use		6593

5.3104.4 Optimize Outdoor Reset Boiler Controller (Hot Water)

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Maintenance, Testing, and Repair

Desired Outcome: Varied distribution loop temperatures match seasonal heating load

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3104.4a Verify proper placement and condition of indoor and outdoor sensors	Sensor location and condition will be assessed in accordance with SWS 5.3102.5 Installation of Outdoor Reset Boiler Controller (Hot Water)	Determine optimal location for sensor installation		6512

5.3104.4b Repair and reinstall, as necessary	Repair and reinstall will be in accordance with SWS 5.3102.5 Installation of Outdoor Reset Boiler Controller (Hot Water)	Ensure proper functionality of the control		6513
5.3104.4c Determine minimum boiler return water temperature	Manufacturer specifications will be reviewed to determine minimum boiler water return temperature requirements	Ensure boiler operates within design parameters		6514
5.3104.4d Set initial high and low operating temperatures	High and low temperatures will be set in accordance with system design, operator feedback, and/or historical data Minimum boiler water temperature requirement will be maintained to prevent thermal shock and flue gas condensation	Maintain minimum building heat requirements without compromising boiler integrity		6515
5.3104.4e Modify operating set points based on observed system performance	Accurate supply and return temperatures will be obtained and compared to design distribution loop temperature differential on representative mild, cold, and design temperature days Settings will be adjusted to maintain design distribution loop differential temperature on representative mild, cold, and design temperature days Minimum boiler water temperature requirement will be maintained	Ensure optimal settings based on actual operating conditions Limit system overheating and improving boiler thermal efficiency		6516
5.3104.4f Record and report settings	Observed supply, return, outdoor temperatures, and all control set points on representative mild, cold, and design temperature days will be documented and provided to building operations staff	Ensure written record of settings		6517
5.3104.4g Educate building operations staff	Building operations staff will be educated to operate outdoor reset control, including sensor location, control operation, and set points	Ensure continued optimized performance		6518

5.3104.5 Optimize Outdoor Reset Valve Controller (Hot Water)

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Maintenance, Testing, and Repair

Desired Outcome: Varied distribution loop temperatures match seasonal heating load

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3104.5a Verify proper placement and condition of indoor and outdoor sensors	Sensor location and condition will be assessed in accordance with SWS 5.3102.6 Installation of Outdoor Reset Valve and Controller (Hot Water)	Determine optimal location for sensor installation		6519
5.3104.5b Repair and reinstall, as necessary	Repair and reinstall will be in accordance with SWS 5.3102.6 Installation of Outdoor Reset Valve and Controller (Hot Water)	Ensure proper functionality of the control		6520
5.3104.5c Set initial high and low operating temperatures	High and low temperatures will be set in accordance with system design, operator feedback, and/or historical data Minimum distribution loop water temperature requirement will be maintained	Maintain minimum building heat requirements		6521
5.3104.5d Modify operating set points based on observed system performance	Accurate supply and return temperatures will be obtained and compared to design distribution loop temperature differential on representative mild, cold, and design temperature days Settings will be adjusted to maintain design distribution loop differential temperature on representative mild, cold, and design temperature days Minimum distribution loop water temperature requirement will be maintained	Ensure optimal settings based on actual operating conditions to limit system overheating and improving boiler energy use		6522
5.3104.5e Record and report settings	Observed supply, return, outdoor temperatures, and all control set points on representative mild, cold, and design temperature days will be documented and provided to building operations staff	Ensure written record of settings		6523
5.3104.5f Educate building operations staff	Building operations staff will be educated to operate outdoor reset control, including sensor location, control operation, and set points	Ensure continued optimized performance		6524

5.3104.6 Repair/Replace Existing Thermostatically Controlled Zone Valves (Hot Water)

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Maintenance, Testing, and Repair

Desired Outcome: Restored functionality of individual zone control valves

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3104.6a Check for presence of asbestos-containing materials (ACMs)	Potential ACMs will be handled in accordance with SWS 2.0110.2 Potential Asbestos-Containing Materials	Ensure a safe work environment		6525
5.3104.6b Replace failed actuator	Actuator will be removed from valve stem and energized to check for functionality Failed actuators will be replaced in accordance with manufacturer specifications If actuator will not operate valve, valve will be replaced	Confirm actuator operation		6526
5.3104.6c Isolate zone valve location	Nearest valves on either side of valve location will be closed	Eliminate the water supply to the valve location		6527
5.3104.6d Install zone valve	Zone valve will be replaced in accordance with valve manufacturer specifications System will be refilled and air will be eliminated	Allow distribution loop to flow to the bypass zone and eliminate overheated and underheated zones		6528
5.3104.6e Reinsulate area	Where insulation was removed, valve will be reinsulated with new insulation to IECC and ASHRAE 90.1, at a minimum	Reduce energy loss Maintain safe surface temperature		6529

5.3104.7 Combined Heat and Domestic Hot Water Systems Tuneup (Includes Hot Water)

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Maintenance, Testing, and Repair

Desired Outcome: Increased efficiency of existing system

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3104.7a Assessment	Field and site conditions will be verified to determine if scope of work is applicable	Ensure optimal system is applied		6530

	Assessment will determine whether higher efficient system is possible			
5.3104.7b Tuneup	Heat exchanger will be flushed and cleaned of scale Performance of heat exchanger will be in accordance with manufacturer specifications and confirmed by a contractor Intent of control strategy will be confirmed by a contractor: • Winter and summer modes/operation • Domestic hot water (DHW) priority • Lead-lag/sequencing • Modulation • Pumps Burner will be tuned for optimal combustion efficiency Also refer to SWS 5.3104.14 Tune-up and Upgrades	Ensure optimal operation of existing system		6531
5.3104.7c Testing	Heating and DHW production, distribution system, and delivery temperature will be tested for proper and safe operation Combustion efficiency will be verified using combustion analyzer for all fuel types, and if applicable, at multiple firing rates	Ensure system operates safely and efficiently		6532
5.3104.7d Education	Property manager will be educated on proper operation and maintenance	Maintain optimal performance		6533

5.3104.8 Boiler Water Treatment

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Maintenance, Testing, and Repair

Desired Outcome: Boiler and piping systems protected from scale and corrosion

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3104.8a Assessment/testing	For hydronic hot water and steam systems, testing frequency will match industry standards and manufacturer specifications For hydronic hot water and steam systems, testing will be conducted at new installation and any modification/repair The quality of the water will be tested for impurities in accordance	Determine if chemical treatment is needed, and if applicable, the type of chemical treatment		6534

	with the boiler manufacturer specifications Service and maintenance will be performed before treatment In no case shall boiler treatment be added to a system that does not have proper backflow protection on the potable water source			
5.3104.8b Addition of chemicals	Chemicals will be added in accordance with manufacturer specifications for local conditions Post-addition test will be performed to verify appropriate treatment was achieved	Ensure boiler water is within optimal quality Ensure maximum efficiency and longevity		6535
5.3104.8c Education	Pre- and post-treatment test results will be provided to property manager/occupant Property manager or outside contractor will be responsible for testing and ongoing treatment and safe storage of chemicals	Verify water quality is maintained		6536

5.3104.9 Inspection Checklist

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Maintenance, Testing, and Repair

Desired Outcome: Thorough maintenance improves safety, efficiency, and performance

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3104.9a Check for presence of asbestos-containing materials (ACMs)	Potential ACMs will be handled in accordance with SWS 2.0110.2 Potential Asbestos-Containing Materials	Ensure safe work environment		6537
5.3104.9b Health and safety	Boiler room makeup air openings shall be in compliance with original equipment manufacturer (OEM) requirements and NFPA 54 and NFPA 31	Identify potential health and safety issues		6538
5.3104.9c Visual inspection	The following conditions will be inspected: • Water, steam, and fuel leaks • Damaged or missing pipe insulation	Observe general conditions to determine needed repairs or maintenance		6539

	• Draft and condensation venting issues (e.g., soot, rusting of flue pipe, burned paint or wires, efflorescence) • Corrosion (e.g., rust, mineral deposits) • General condition of components • Controls and control settings			
5.3104.9d Pipe, tank, and boiler insulation inspection	Pipe, tank, and boiler insulation will be inspected, including: • Integrity—complete coverage, no holes or tears • Damage—holes or tears • Complete coverage—insulation missing If asbestos is suspected, occupants will be notified, and asbestos will not be disturbed Required repair or replacement will be performed in accordance with the following conditions: • Materials will be approved for steam heating pipes • Materials will be approved for hot water heating pipes • Insulation will completely cover pipe Pipe, tank, and boiler insulation will be installed in accordance with manufacturer specifications	Minimize heat loss Improve the performance of the system		6540
5.3104.9e System static pressure	For hot water systems, static pressure will be verified	Keep system operating within pressure parameters		6541
5.3104.9f Purge system	Each accessible heat emitter will be purged	Remove air from the system to maximize performance		6542
5.3104.9g Automatic fill for hot water boilers	Automatic fill valve will be inspected to ensure it maintains system pressure If pressure is not maintained, replacement will be made in accordance with the following criteria: • A backflow preventer will be installed upstream of automatic fill valve if one is not existing • Automatic fill valve and components will be installed	Maintain optimal system pressure to maximize performance		6543

	in accordance with manufacturer specifications • Correct system pressure will be verified			
5.3104.9h Gauge glass: steam boiler	Gauge glass will be inspected for erosion, cracks, or drying Damaged gauge glass on boiler will be replaced in accordance with manufacturer specifications Gauge glass that is coated with dirt or sediment, making it difficult to observe the water level of the boiler, will be removed, cleaned, and replaced	Ensure gauge glass is in safe operating condition to allow observation of the water level in the steam boiler		6544
5.3104.9i Low water cutoff: float type	Operation of low water cutoff will be observed by opening blow-off valve If combustion is not extinguished, remediation will be accomplished by the following procedure: • Electricity will be disconnected from boiler • Problem will be diagnosed • Low water cutoff will be repaired, serviced, or replaced in accordance with manufacturer specifications • A blow-down valve will be added if not already present • Boiler will be retested for proper operation Building/property management team and operations staff will be educated on the correct method to drain the low water cutoff weekly (must drain once per week to remove sediment from float chamber of low water cutoff)	Ensure safe minimum water level of the boiler Maintain safe operation of the low water cutoff on an ongoing basis		6545
5.3104.9j Low water cutoff: probe type	A probe type low water cutoff will be installed and operable Low water cutoff with manual reset switch will be installed in accordance with local code requirements	Ensure a safe minimum water level of the boiler		6546
5.3104.9k Expansion tank: non-bladder and bladder	An expansion tank will be installed and operable Tanks that leak or have excessive corrosion will be replaced and non-bladder tanks will include an expansion tank drain Tank will be installed in accordance with manufacturer specifications	Absorb water expansion of the system		6547

	Expansion tanks will be properly supported with strapping Tanks that are full of water will be drained and refilled before being replaced or repaired Expansion tanks with bladders will be pre-charged, minimum to system static pressure, while water is not present in the tank Bladder tanks that have water inside of the air bladder will be replaced in accordance with manufacturer specifications			
5.3104.9l Flush or skim steam boiler	Flushing or skimming steam boiler will be in accordance with manufacturer specifications Blow down after cooler shall be tested	Ensure boiler produces dry steam		6548
5.3104.9m System temperature or pressure gauge	The temperature or pressure gauge will be inspected for erosion, cracks or dirt Damaged temperature or pressure gauges will be replaced in accordance with manufacturer specifications (see SWS 5.3103.7 Installation of Pressure Gauges	Allow for accurate observation of system temperature and pressure		6549
5.3104.9n Circulating pumps	Nonworking motors that cannot be serviced will be replaced with a new, premium efficiency motor New motors will be installed in accordance with manufacturer specifications Oil-lubricated circulating pumps will be installed in proper alignment with the pump coupler and will be supported so they do not sag Bearings will have free movement and no water leakage New circulator will be installed as per SWS 5.3102.16 Installation of Individual and Redundant Pumps	Ensure circulation of water at designated velocity in system without leaks in the circulating pumps		6550
5.3104.9o Zone valves	Zone valves will be inspected for the following conditions: • Leaking water • Not responding to a call for heat New equipment will be replaced in accordance with manufacturer specifications	Ensure proper zonal control of the system for comfort and efficiency		6551

5.3104.9p Flue gas condensate	If boiler is 90% efficient or greater, a neutralization kit will be installed to neutralize flue gas condensate before discharging it in accordance with local code requirements Condensate pumps will be installed if needed to ensure proper drainage Condensate neutralization kit shall be installed in such a way that the remaining neutralizing agent level is easily viewed and replaced	Bring condensate to an acceptable pH and discharge to an appropriate location		6552
5.3104.9q Air vents: steam systems	Occupant will be informed that air vents have potential to cause moisture problems if not operating properly Occupant will be reminded to call for maintenance if vents discharge steam or have moisture issues	Maintain efficient operation of the system		6553
5.3104.9r Maintenance records	Keeping records of all maintenance will be recommended to occupants Copies or access to installation and operation manuals will be provided	Provide system installation and maintenance history to improve future maintenance or repair		6554
5.3104.9s Occupant health and 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 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		6555
5.3104.9t Education	Completed work will be reviewed Occupants will be educated on the safe and efficient operation and maintenance of the system	Ensure occupant is informed of the safe, efficient operation and maintenance of the system		6556

5.3188.1 Water Drainage in the Boiler Room

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Special Considerations

Desired Outcome: No standing water in the boiler room

TITLE	SPECIFICATION(S)	OBJECTIVE(S)	

5.3188.1a Assessment of existing conditions	Evidence of chronic standing water in boiler room will be addressed before installation of any new equipment	Ensure occupant safety Protect equipment		6594
5.3188.1b Blow-down piping	Maintenance blow-down piping will be routed to the nearest drain	Ensure standing water is not on the mechanical room floor		6595
5.3188.1c Drain condition	Entire drain system will be free of debris and will work properly Drain system will be capable of handling maximum volume of water Draining issues will be communicated to property manager/occupant	Ensure proper drainage and discharge		6596
5.3188.1d Blow-down pit	If present, blow-down pit will be cleaned to handle the volume of water required to sufficiently reduce blow-down temperature for safe discharge Blow-down pit connection to the drain system will be free and clear	Ensure blow-down temperature is within acceptable temperatures		6597
5.3188.1e Sump pump/sump pit	If present, sump pit will be sized to handle the volume of water required to sufficiently reduce water temperature for safe discharge Sump pump will be rated for high-temperature application, if applicable Sump pump will be checked for proper operation Check valve will be installed on piping between discharge side of the sump pump and termination point	Collect and properly discharge water		6598

5.3188.2 Adding Mass to Low Mass Boiler—Existing or New

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Special Considerations

Desired Outcome: Minimized potential for short cycling, premature component failure, and increased operational efficiencies

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3188.2a Check for presence of asbestos-containing materials (ACMs)	Potential ACMs will be handled in accordance with SWS 2.0110.2 Potential Asbestos-Containing Materials	Ensure a safe work environment		6599

5.3188.2b Application	Need for and size of buffer tank will be based on system design and boiler manufacturer specifications When the smallest heating/hot water load is less than the minimum firing rate, a buffer tank will be added	Reduce short cycling		6600
5.3188.2c Insulation	Buffer tank will be insulated to a minimum R-12	Minimize tank heat loss		6601
5.3188.2d Location	Connection points to the piping system will be verified in accordance with work order and site conditions	Ensure the proper operation		6602
5.3188.2e Install buffer tank	Nearest valves on either side of buffer tank location will be closed Buffer tank will be installed in accordance with manufacturer specifications Buffer tank will be installed on a level concrete pad to minimize corrosion at the bottom Valves will be opened and system will be refilled and air will be eliminated	Eliminate water supply to buffer tank location Properly install buffer tank		6603
5.3188.2f Insulate buffer tank area	Buffer tank and associated piping will be insulated with new insulation to IECC and ASHRAE 90.1, at a minimum	Reduce energy loss Maintain safe surface temperature		6604
5.3188.2g Education	Completed work will be reviewed with the building/property management team and operations staff Building/property management team and operations staff will be educated on the safe and efficient operation and maintenance requirements of the installed item	Ensure building/property management team and operations staff is informed of the safe, efficient operation and maintenance requirements of the installed item		6605

5.3188.3 Radiator Reflector

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Special Considerations

Desired Outcome: Minimized heat loss and enhanced terminal unit effectiveness

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3188.3a Terminal heating unit	Reflector will not make contact with heating element Air space will be maintained between heating element and reflector	Optimize efficiency		6606

5.3188.3b Installing insulation	Insulation will be covered by a reflective surface Appearance will be considered by architect/property manager/occupant Reflectors will be securely attached	Ensure maximum performance of terminal unit		6607
5.3188.3c Education	Reflectors will be kept clean Reflectors will be cleaned when unit is not hot	Safely maintain performance		6608

5.3202.2 Reflective Roof Coatings

Topic: Shading

Subtopic: Reflective Roofs

Desired Outcome: Reduced solar heat gain and increased reflectance of the roof

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3202.2a Roof coating/membrane selection	Assess condition of existing roof system and correct all deficiencies prior to application of reflective coating Reflective coatings will only be applied to roofing systems where its application is approved by the roofing manufacturer A reflective roof coating/membrane that meets the LEED New Construction Reflective Roof standard will be used where regionally appropriate	Preserve durability of improvement Ensure compatibility between existing roof system and proposed reflective coating Ensure effectiveness of application		6609

5.3301.1 In-Unit Indoor Ceiling Fan Replacement

Topic: Non-Distribution Cooling Systems

Subtopic: Ceiling and Other Fans

Desired Outcome: Energy used for ceiling fans reduced

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 Building America Solution Center.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3301.1a Assessment	Existing outlet box will be inspected for manufacturer marking, indicating the outlet box	Ensure occupant safety Determine feasibility		6610

	is suitable for fan mounting [NFPA 70, Section 314.27(C)] Work order will be evaluated against site circumstances			
5.3301.1b Selection	Fan will match existing switching and wiring configuration, unless modifications are made to allow for automatic control of the fan (e.g., occupancy or daylight sensors, etc.) Fan will be ENERGY STAR® qualified or better Existing fan will be replaced with a fan of similar functionality and size Fan and installation will carry a minimum 1-year warranty If the lighting is being controlled by a dimmer, ensure replacement lamps are dimming capable; alternatively, the dimmer control can be removed and replaced with an on/off control	Ensure fan usability Reduce energy use Ensure occupant satisfaction		6611
5.3301.1c Installation	Work will be performed by licensed electrical professional Outlet will be de-energized before work begins Appropriate lockout procedures will be followed in accordance with OSHA 1910 Subpart S and ANSI/NFPA 70E Fan will be installed in accordance with NFPA 70, IFC Section 903, NFPA 13R, and manufacturer specifications Worker will verify outlet box is secured and supported Screw base lamps will be ENERGY STAR qualified or exceed Energy Independence and Security Act 2014 standard levels by at least 20% All penetrations will be sealed (ANSI/NFPA/ICC Fire Code) Any penetrations created will be patched and painted	Ensure worker safety Ensure occupant safety Ensure continued energy savings Optimize fixture performance Reduce energy use Ensure integrity of fire barrier Ensure integrity of building envelope		6612
5.3301.1d Commissioning	Worker will ensure fan operates in accordance with manufacturer specifications and test fan accordingly	Ensure occupant satisfaction Ensure occupant safety		6613

5.3301.1e Decommissioning	Lamps will be disposed of in accordance with local ordinances or manufacturer specifications	Protect the environment Prevent the reuse of inefficient components		6614
5.3301.1f Safety	Broken lamps containing mercury will be cleaned in accordance with EPA guidelines, unless EPA regulations require qualified personnel to clean broken lamp area	Ensure worker safety Ensure occupant safety		6615
5.3301.1g Staff education	Building operations staff will be provided with warranty information, product specification, and installer contact information	Educate building operations staff about operation and maintenance of equipment Ensure continued savings		6616
5.3301.1h Occupant education	Occupants will be provided with a manual and educated of new fan benefits Occupant will be provided with lamp disposal procedure determined by building operations staff If lamps containing mercury are used, occupants will be provided with lamp disposal procedure in accordance with EPA guidelines Building operations staff will provide education and shall make available one copy of the owner's/operator's manual to the operator of the equipment	Educate occupants about new fan and benefits Ensure continued savings Protect the environment Ensure occupant safety		6617

5.3302.1 Through-Wall and Room Air Conditioning Unit Replacement

Topic: Non-Distribution Cooling Systems

Subtopic: Room Air Conditioners

Desired Outcome: Energy used for air conditioning reduced

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3302.1a Assessment	Physical size of through-wall opening will be determined Unit and electrical receptacle will meet requirements of NFPA 70 Article 440 Work order will be evaluated against site circumstances	Determine and ensure appropriate device and location		6618

5.3302.1b Selection	Unit will match available voltage and not exceed current available voltage at the existing electrical outlet Replacement unit will provide same or better functionality than existing unit, but smaller duty unit will be provided if existing is oversized Replacement unit will be ENERGY STAR® qualified with Energy Saver Mode or better Units with R22 refrigerant will not be used	Ensure proper device function Avoid adding additional load Reduce energy use Protect the environment		6619
5.3302.1c Installation	Extension cord will not be used (NFPA 70 Article 440) Where applicable unit controls and thermostat shall comply with the operable parts provisions of ICC A117.1 when the dwelling unit is required to be accessible per ADA Unit will be self-supporting or permanently installed Perimeter of unit will be sealed with a durable material (ASTM C1193) Egress will be addressed to be in accordance with ANSI/NFPA 101 and local laws	Ensure integrity of building envelope Ensure occupant comfort Ensure occupant safety Ensure continued savings		6620
5.3302.1d Decommissioning	Units replaced will be recycled or disposed of in accordance with local ordinances Refrigerant will be handled in accordance with Section 608 of Clean Air Act of 1990 and local ordinances	Prevent reuse of inefficient equipment and components Protect the environment		6621
5.3302.1e Staff education	Building operations staff will be educated on strategies for winterizing cooling-only equipment Window units will be removed and stored during long periods of cold and snow When unit is not in use, it will be closed and covered in accordance with Envelope Wall Penetration Standard Work Specification (SWS, section 3.1102.1 Building operations staff will be provided with warranty	Prevent energy loss Educate building operations staff about operation and maintenance of equipment Ensure continued savings		6622

	information, operation manuals, and installer contact information			
5.3302.1f Occupant education	Occupants will be provided with a manual and educated of new unit benefits Education will be provided by building operations staff	Educate occupants about new controls and benefits Ensure continued savings		6623

Section 6: Ventilation

6.6004.1 Central/Common Exhaust Fan Serving Multiple Dwelling Units via Common Duct(s) and Dwelling Unit Branches

Topic: Exhaust

Subtopic: Exhaust Ventilation Systems

Desired Outcome: Multiport fan system installed to provide required ventilation

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

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
6.6004.1a Pre-inspection	Specifications will be field verified as appropriate to site conditions by installer	Ensure appropriate design for installation		4697
6.6004.1b Air flow	ASHRAE 62.2 and local code requirements should be followed for identifying design airflow rates within apartment dwelling units. All other areas will follow local code requirements and/or ASHRAE 62.1 requirements Air flows will be measured in accordance with ANSI/ACCA Standard 5 or ANSI/ASHRAE Standard 111 and adjusted to meet design requirements	Exhaust sufficient air from desired locations to the outdoors		4698
6.6004.1c Fan specification	Motors of 1 horsepower (HP) or larger will be rated as Premium Efficiency by the National Electrical Manufacturer's Association (NEMA) Fan will be capable of maintaining a minimum operating static pressure of .25 inches of water column (WC) or the pressure that is required by the system design to	Ensure proper flow rate sizing of exhaust fans		4699

	ensure proper operation of all system components Motors less than 1 HP, used for continuous whole-building ventilation, will be rated by the Home Ventilation Institute to provide at least the required ventilation rate at a minimum operating static pressure of .25 inches WC or the pressure that is required by the system design to ensure proper operation of all system components			
6.6004.1d Fan outlet termination	Outlet will be terminated outside of the building shell and will have a louvered cover and bird screen Minimum distance of exhaust outlet from any doors, windows, or outside air intakes shall be in conformance with the applicable building code Outlet will be sealed to prevent water intrusion and exhaust air leakage into building cavities	Direct exhaust to the outdoors and prevent re-entry Prevent entry of weather and pests into building shell Ensure occupant health and safety		4700
6.6004.1e Wiring	Wiring will be installed by a licensed contractor Wiring will be installed in accordance with original equipment manufacturer specifications, and local and national electrical and mechanical codes Refer to NFPA 70: National Electrical Code	Prevent an electrical hazard		4701
6.6004.1f Access	Fan and service switch will be accessible for maintenance	Ensure unit and service switch are accessible for maintenance or replacement		4702
6.6004.1g Outdoor/indoor fan mounting	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 and local code requirements (in terms of seismic restraints, vibration, and noise control) Fan will be isolated from the building framing unless specifically designed to be directly attached	Ensure short duct runs to achieve optimum air flows Ensure mounting is installed securely Ensure fan housing or building framing does not shake, rattle, or hum when operating Minimize noise		4703

6.6004.1h Connecting exposed ductwork	All exposed ductwork outside of the building will be insulated to a minimum R-8, protected from weather exposure, and sealed at all penetrations into building shell	Ensure durability and energy efficiency of ductwork		4704
6.6004.1i Fan/duct riser connection	If fan is on curb, the riser will be flashed to the top of the curb and the fan will be sealed to the riser flashing If the fan is separate from the curb, the riser will be flashed to the top of the curb Duct connector will be sealed to the top of the riser flashing Ductwork will be attached via a flexible connection and will maintain the intended fan opening	Provide the most efficient air transfer from targeted location to exhaust location		4705
6.6004.1j Backdraft dampers	A backdraft damper will be installed at or near the fan A backdraft damper will be installed at each dwelling unit unless the fan runs on a continuous operating system	Prevent reverse air flow when the system is off Prevent spread of contaminants between dwelling units		4706
6.6004.1k Combining intake ducts	All individual intake ducts will be combined on the inlet side of fan (e.g., Y-fitting, T-fitting, collector box)	Exhaust air from desired locations to the outdoors		4707
6.6004.1l Duct connections	All riser ducts or plenums will be connected and sealed to applicable intakes, collector box, fan, and termination fitting Sealing activities will not interfere with the operation of fire dampers, balancing dampers, or backdraft dampers Ducts will be connected and sealed in accordance with the applicable code adopted by the jurisdiction	Exhaust air from desired locations to the outdoors Preserve integrity of the duct system and building envelope		4708
6.6004.1m Insulation	All components outside of the thermal envelope will be insulated to a minimum of R-8 or equivalent to local codes	Preserve integrity of the duct system Prevent condensation in ductwork Prevent heat loss		4709
6.6004.1n Register boot to interior surface seal	Register boot will be sealed to interior surfaces with sealants compatible to their intended surfaces Sealants will be continuous and meet fire barrier specifications	Prevent air leakage around boot Ensure a permanent seal to the building air barrier Prevent a fire hazard		4710

6.6004.1o Preventing air leakage caused by exhaust fans	Walls, ceilings, and floors will be sealed to separate any occupied space from any unconditioned spaces and adjacent dwelling units Refer to ASHRAE 62.2 Addendum J	Ensure occupant health and safety Prevent air leakage into the building and dwelling units from other spaces (e.g., adjacent dwelling units, garages, unconditioned crawl spaces, unconditioned attics)		4711
6.6004.1p Balance and flow	Air flows will be measured and adjusted to match the design specification in accordance with ANSI ACCA Standard 5 or ANSI/ASHRAE Standard 111	Achieve the desired air flows to and from the desired locations		4712
6.6004.1q Combustion zone testing	Pressure effects caused by fans will be assessed and corrected when found outside of combustion safety standards	Ensure safe operation of combustion appliances		4713
6.6004.1r Fire dampers	Fire dampers must be accessible for inspection and/or testing by the local authorities; if fire dampers are not accessible from a grill or register, an access door in the ductwork is required Sealing activities will not interfere with the operation of fire dampers, balancing dampers, or backdraft dampers Type B fire dampers will be used as required by fire code	Ensure access to fire dampers for safe operation Minimize static pressure Maximize air flow		4714
6.6004.1s Occupant/property manager education	Occupant/property manager will be educated on purpose and value of system Property manager will be instructed on all maintenance procedures	Ensure occupant health and safety Preserve integrity of system		4715

6.6004.2 Individual Exhaust Fan Serving Multiple Rooms Within Single Dwelling Unit (All Building Types)

Topic: Exhaust

Subtopic: Exhaust Ventilation Systems

Desired Outcome: Multiport fan system installed to provide required ventilation

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

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)	

6.6004.2a Pre-inspection	Specifications will be field verified as appropriate to site conditions by installer	Ensure appropriate design for installation		4716
6.6004.2b Air flow	ASHRAE 62.2 and local code requirements should be followed for identifying design airflow rates within apartment dwelling units. All other areas will follow local code requirements and/or ASHRAE 62.1 requirements Air flows will be measured in accordance with ANSI/ACCA Standard 5 or ANSI/ASHRAE Standard 111 and adjusted to meet design requirements	Exhaust sufficient air from desired locations to the outdoors		4717
6.6004.2c Outlet termination	Outlet will be terminated outside of the building shell and will have a louvered cover and bird screen Minimum distance of exhaust outlet from any doors, windows, or outside air intakes shall be in conformance with the applicable building code Outlet will be sealed to prevent water intrusion and exhaust air leakage into building cavities	Direct exhaust to the outdoors and prevent re-entry Prevent entry of weather and pests into building shell Ensure occupant health and safety		4718
6.6004.2d Wiring	Wiring will be installed by a properly licensed contractor Wiring will be installed in accordance with original equipment manufacturer specifications, and local and national electrical and mechanical codes Refer to NFPA 70: National Electrical Code for installation requirements	Prevent an electrical hazard		4719
6.6004.2e Access	Fan and service switch will be accessible for maintenance	Ensure unit and service switch are accessible for maintenance or replacement		4720
6.6004.2f Fan mounting	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 and local code requirements (in terms of seismic restraints, vibration, and noise control)	Ensure short duct runs to achieve optimum air flows Ensure mounting is installed securely Ensure fan housing or building framing does not shake, rattle, or hum when operating Minimize noise		4721

	Fan will be isolated from the building framing unless specifically designed to be directly attached Fan will be installed remotely by ducting from intake grilles			
6.6004.2g Backdraft dampers (required in intermittent systems)	A backdraft damper will be installed between the fan and the exterior A backdraft damper will be installed in any duct serving any room with a separate exhaust (e.g., dryer)	Prevent reverse air flow when the system is off Prevent spread of contaminants between rooms		4722
6.6004.2h Combining intake ducts	All individual intake ducts will be combined on the intake side of fan (e.g., Y-fitting, T-fitting, collector box)	Exhaust air from desired locations to the outdoors		4723
6.6004.2i Duct connections	Ducts will be connected and sealed to applicable intakes, collector box, fan, and termination fitting Ducts will be connected and sealed in accordance with the applicable code adopted by the jurisdiction	Exhaust air from desired locations to the outdoors Preserve integrity of the duct system and building envelope		4724
6.6004.2j Insulation	All components outside of the thermal envelope will be insulated to a minimum of R-8 or equivalent to local codes	Preserve integrity of the duct system Prevent condensation in ductwork Prevent heat loss		4725
6.6004.2k Boot to interior surface seal	Register boot will be sealed to interior surfaces with sealants compatible to their intended surfaces Sealants will be continuous and meet fire barrier specifications Boots will be connected and sealed in accordance with the applicable code adopted by the jurisdiction	Prevent air leakage around boot Ensure a permanent seal to the building air barrier Prevent a fire hazard		4726
6.6004.2l Preventing air leakage caused by exhaust fans	Walls, ceilings, and floors will be sealed to separate any occupied space from any unconditioned spaces and adjacent dwelling units Refer to ASHRAE 62.2 Section 6.1	Ensure occupant health and safety Prevent air leakage into the building from other spaces (e.g., adjacent dwelling units, garages, unconditioned crawl spaces, unconditioned attics)		4727
6.6004.2m Balance and flow	Air flows will be measured and adjusted to match to the design specification	Achieve the desired air flows to and from the desired locations		4728

6.6004.2n Combustion zone testing	Pressure effects caused by fans will be assessed and corrected when found outside of combustion safety standards	Ensure safe operation of combustion appliances		4729
6.6004.2o Fire dampers	Fire dampers must be accessible for inspection and/or testing by the local authorities; if fire dampers are not accessible from a grill or register, an access door in the ductwork is required Sealing activities will not interfere with the operation of fire dampers, balancing dampers, or backdraft dampers Type B fire dampers will be used as required by fire code	Ensure access to fire dampers for safe operation Minimize static pressure Maximize air flow		4730
6.6004.2p Occupant/property manager education	Occupant/property manager will be educated on purpose and value of system Property manager will be instructed on all maintenance procedures	Ensure occupant health and safety Preserve integrity of system		4731

6.6004.3 Garage Exhaust Fan (All Building Types)

Topic: Exhaust

Subtopic: Exhaust Ventilation Systems

Desired Outcome: Contaminants properly removed from garage

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

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
6.6004.3a Pre-inspection	Specifications will be field verified as appropriate to site conditions by installer	Ensure appropriate design for installation		4732
6.6004.3b System selection	Garage will be ventilated at a minimum of 100 cubic feet per minute (CFM) of ventilation per vehicle bay When single garage serves multiple dwellings, fan will run continuously System will provide exhaust at a minimum of 0.75 CFM/square feet Minimum distance of exhaust outlet from any doors, windows, or outside air intakes will meet	Remove contaminants from garage Reduce contaminant migration from garage to building Ensure occupant health and safety		4733

	specifications of ASHRAE 62.1 Table 5-1 Motors 1 horsepower or larger will meet NEMA standards			
6.6004.3c Wiring	Wiring will be installed by a licensed contractor Wiring will be installed in accordance with original equipment manufacturer specifications local and national electrical and mechanical codes Refer to NFPA: National Electrical Code for installation requirements	Prevent an electrical hazard		4734
6.6004.3d Access	Fan and service switch will be accessible for maintenance	Ensure unit and service switch are accessible for maintenance or replacement		4735
6.6004.3e Outdoor/indoor 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 and local code requirements (in terms of seismic restraints) Fan will be isolated from the building framing unless specifically designed to be directly attached	Ensure short duct runs to achieve optimum air flows Ensure mounting is installed securely Ensure fan housing or building framing does not shake, rattle, or hum when operating Minimize noise		4736
6.6004.3f Air leakage	Air leakage between the building and garages will be prevented by envelope sealing, weather stripping, and duct sealing following SWS 3.1502.1 Garages - Isolating from Living Spaces and SWS 3.1502.2 Removing Supply and/or Return Registers From Garages	Ensure occupant health and safety Reduce conditioned air being drawn from the building Reduce contaminant migration from garage to building		4737
6.6004.3g Verification	Exhaust flow rates will be measured in accordance with ANSI/ACCA Standard 5 or ANSI/ASHRAE Standard 111 and documented to meet design requirements If intermittent system is installed, proper operation of controls will be confirmed	Ensure the performance of the ventilation system Ensure occupant health and safety		4738
6.6004.3h Combustion zone testing	If combustion equipment is located inside of or adjacent to garage, then pressure effects caused by fans will be assessed and corrected when	Ensure safe operation of combustion appliances Ensure occupant health and safety		4739

	found outside of combustion safety standards			
6.6004.3i Property manager education	Property manager will be educated on how the system works and its purpose and proper maintenance Property manager will be educated on maintenance procedures	Ensure the durability of the exhaust system		4740

6.6005.3 Clothes Dryer (All Building Types)

Topic: Exhaust

Subtopic: Appliance Exhaust Vents

Desired Outcome: Dryer air exhausted efficiently and safely

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
6.6005.3a Pre-inspection	Specifications will be field verified as appropriate to site conditions by installer	Ensure appropriate design for installation		4741
6.6005.3b Clothes dryer ducting	Clothes dryers exhaust will be ducted to the outdoors As short a run as practical of smooth wall metal duct will be used, following manufacturer specifications and the applicable code adopted by the jurisdiction Dryer ducts exceeding the manufacturer's recommended maximum length or the maximum length specified by the applicable code adopted by the jurisdiction shall have a dryer booster fan installed, and shall have a safety interlock with the dryer(s) so they will not operate if the fan is not operating properly When multiple dryers vent into a common plenum or stack, the system will be engineered by a design professional and installed with a terminal exhaust fan Ducting will be connected and sealed as described in exhaust details SWS 6.6004.1 Centra/Common Exhaust Fan Serving Multiple Dwelling Units via Common Duct(s) and Dwelling Unit Branches and SWS	Preserve integrity of building envelope Effectively move air from clothes dryer to the outdoors Meet code requirements Remove moisture, lint, and excess heat from laundry area		4742

	6.6004.2 Individual Exhaust Fan Serving Multiple Rooms Within a Single Dwelling Unit (All 3 Building Types) Fasteners that obstruct the exhaust flow will not be used Condensing dryers will be plumbed to a drain that leads to an approved sanitary disposal system			
6.6005.3c Termination fitting	Termination fitting manufactured for use with dryers will be installed A backdraft damper will be included as described in termination fitting detail Minimum distance of exhaust outlets installed new from any doors or operable windows or outside air intakes will meet local code requirements or specifications of ASHRAE 62.1 Table 5-1 requirements Outlet will be sealed to prevent water and air intrusion	Preserve integrity of building envelope Effectively move air from clothes dryer to the outdoors Direct exhaust to the outdoors and prevent re-entry Prevent entry of weather and pests into building shell Ensure occupant health and safety		4743
6.6005.3d Makeup air	When dryer(s) are installed in a single room, makeup air will be designed following the applicable code adopted by the jurisdiction	Preserve integrity of building envelope Effectively move air from clothes dryer to the outdoors		4744
6.6005.3e Verification	Visual inspection of installation and air flow out of the building will be completed	Ensure the performance of the ventilation system Ensure occupant health and safety		4745
6.6005.3f Combustion zone testing	Pressure effects caused by fans will be assessed and corrected when found outside of combustion safety standards	Ensure safe operation of combustion appliances Ensure occupant health and safety		4746
6.6005.3g Occupant/property manager education	Occupant/property manager will be instructed to keep lint filter and termination fitting clean	Effectively move air from clothes dryer to the outdoors		4747

6.6005.4 Kitchen Range Hood within Dwelling Unit (All Building Types)

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 Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
6.6005.4a Pre-inspection	Specifications will be field verified as appropriate to site conditions by installer	Ensure appropriate design for installation		4748
6.6005.4b Wiring	Wiring will be installed by a properly licensed contractor Wiring will be installed in accordance with original equipment manufacturer specifications, and local and national electrical and mechanical codes Refer to NFPA 70: National Electrical Code for installation requirements	Prevent an electrical hazard		4749
6.6005.4c Fan selection/specification	Fans installed in range hoods over cooking appliances will be designed per Home Ventilation Institute 2100 specifications Air flow rate will be a minimum of 100 cubic feet per minute (CFM)	Provide adequate ventilation to remove odors and contaminants		4750
6.6005.4d Fan venting	Kitchen range fans will be vented directly to the outside Recirculating fans will not be used as a ventilating device	Remove odors and cooking contaminants from the building Preserve integrity of building envelope		4751
6.6005.4e Fan ducting	Kitchen range fans will be ducted directly to the outdoors As short a run as practical of smooth wall metal duct will be used, following manufacturer specifications and IMC 2009 505 Ducting will be connected and sealed as described in exhaust duct details SWS 6.6004.1 Central/Common Exhaust Fan Serving Multiple Dwelling Units via Common Duct(s) and Dwelling Unit Brances and SWS 6.6004.2 Individual Exhaust Fan Serving Multiple Rooms Within a Single Dwelling Unit (All 3 Building Types)	Preserve integrity of building envelope Effectively move air from range to the outdoors		4752
6.6005.4f 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		4753

	Outlet will be terminated outside of the building shell and will have a louvered cover and bird screen Minimum distance of exhaust outlets installed new from any doors or operable windows or outside air intakes will meet local code requirements or specifications of ASHRAE 62.1 Table 5-1 requirements Outlet will be sealed to prevent water and air intrusion	Direct exhaust to the outdoors and prevent re-entry Prevent entry of weather and pests into building shell		
6.6005.4g Makeup air	Makeup air will be provided for kitchen range fans exhausting more than 400 CFM	Ensure safe operation of combustion appliances Minimize air leakage between dwelling units Ensure occupant health and safety		4754
6.6005.4h Verification	Exhaust flow rates will be measured and documented to meet design requirements	Ensure the performance of the ventilation system Ensure occupant health and safety		4755
6.6005.4i Combustion zone testing	Pressure effects caused by fans will be assessed and corrected when found outside of combustion safety standards	Ensure safe operation of combustion appliances Ensure occupant health and safety		4756
6.6005.4j Occupant/property manager education	Occupant/property manager will be instructed to keep grease filters and termination fitting clean	Effectively move air from kitchen range to the outdoors		4757

6.6088.1 Regional Climatic Considerations

Topic: Exhaust

Subtopic: Special Considerations

Desired Outcome: Regional climatic variables are taken into consideration

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
6.6088.1a Very cold	Ventilation terminations will either have no backflow dampers or will use backflow dampers that resist freezing Soffit vents that contain a ventilation exhaust termination will be sealed within 6' of the termination	Avoid ventilation flapper freezing Prevent exhaust moisture from entering the attic		4758
6.6088.1b Cold	Exhaust ventilation will be terminated at the roof, gable end, or wall	Prevent exhaust moisture from entering the attic		4759

6.6088.1c Mixed humid	Ventilation ducts will be insulated to R-8 or greater Ventilation exhaust ducts will be terminated on the exterior of the building Ventilation exhausts terminating through the soffit will direct exhaust air away from the soffit vents	Ensure condensation does not form on or in the ductwork Ensure ventilation exhaust exits the building to the outside Prevent exhaust moisture from entering the attic		4760
6.6088.1d Hot humid	Exhaust-only ventilation will not be installed	Avoid bringing moist outside air into the building		4761

6.6102.5 Detail Name: Supply Register Location

Topic: Supply

Subtopic: Components

Desired Outcome: Supply register location optimizes air flow for primary or spot ventilation devices

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
6.6102.5a Primary whole building	Supply register will be installed in high occupancy rooms or rooms used for sleeping	Provide whole building air exchange		4762
6.6102.5b Spot makeup	A makeup air path and makeup air will be provided for exhaust devices that exceed 200 cubic feet per minute of air flow	Provide makeup air		4763

6.6102.6 Intakes

Topic: Supply

Subtopic: Components

Desired Outcome: Intake optimizes air flow while limiting the entry of insects, debris, and contaminants

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
6.6102.6a Hole in building shell	Holes cut to accommodate the terminal fittings should be no more than 1/8" larger than the fitting itself	Ensure a weather tight installation		4764
6.6102.6b Intake fitting	Intake fitting will have integrated collar at least the same diameter as the duct The fitting will be appropriate for regional weather conditions and	Effectively draw the required volume of air from outside Preserve integrity of the building envelope Ensure durable installation		4765

	installation location on exterior of building			
6.6102.6c Occupant education	Intake fitting will be labeled "ventilation air intake" Occupant will be instructed to keep yard debris and other contaminants clear of the intake	Ensure unrestricted air flow		4766
6.6102.6d Damper (if applicable)	The damper will be installed to open in the direction of the desired flow Damper will close when system is off	Ensure unrestricted air flow		4767
6.6102.6e Connection to intake fitting	Duct to intake fitting will be connected and sealed in accordance with supply duct detail Ensure fasteners do not inhibit intake damper operation	Preserve integrity of the building envelope Ensure a weather tight and durable intake installation Ensure unrestricted air flow		4768
6.6102.6f Weatherproofing	Exterior termination fitting will be flashed or weather sealed Water will be directed away from penetration Installation will not inhibit damper operation Weatherproofing will be in accordance with manufacturer specifications	Preserve integrity of the building envelope Ensure a weather tight and durable intake installation Ensure unrestricted air flow		4769
6.6102.6g Pest exclusion	Screen material no less than 1/4" and no greater than 1/2" hole size in any direction will be used Screen will be installed so it does not inhibit intake damper operation	Prevent pest entry Ensure unrestricted air flow		4770
6.6102.6h Intake location	Intake will be installed in accordance with all applicable code requirements and/or the most current version of ASHRAE 62.2	Prevent contaminants from entering building Ensure unrestricted air flow		4771

6.6102.7 Ducts for Supply

Topic: Supply

Subtopic: Components

Desired Outcome: Supply ducts effectively move the required amount of air and prevent condensation

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
6.6102.7a Duct design and configuration	Duct shall be designed in accordance with the applicable codes adopted by the jurisdiction	Effectively move the required volume of air		4772

6.6102.7b Duct insulation	Ducts installed outside of the thermal envelope will be insulated to a minimum of R-8 or equivalent to local codes	Prevent moisture condensation		4773
6.6102.7c Duct support	Ducts will be supported as required by the applicable code adopted by the jurisdiction for the type of duct used	Effectively move the required volume of air Preserve integrity of the duct system		4774
6.6102.7d 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 Flexible duct between the cable tie and end of metal or PVC duct will be screwed PVC-to-PVC materials will be fastened with approved PVC cement Supply ducts attached to the return side of forced air systems will be: • Attached as close to the heating, ventilation, and air conditioning (HVAC) system's fan as possible while remaining in compliance with manufacturer specifications • Set up to provide filtration of outdoor ventilation air before reaching the HVAC system • Attached via a mechanically fastened take off collar In addition to mechanical fasteners, air seal duct connections will be fastened with UL 181B or 181B-M listed material All other duct connections shall be in conformance with the applicable code adopted by the jurisdiction	Effectively move the required volume of air Preserve integrity of the duct system and building envelope		4775
6.6102.7e Duct materials	Flexible duct materials will be UL 181 listed or Air Diffusion Council approved	Effectively move the required volume of air Preserve integrity of the duct system and building envelope		4776
6.6102.7f Outdoor air intake location	Intake will be installed in accordance with all applicable code requirements and/or the most current version of ASHRAE 62.2	Reduce opportunity for contaminants to enter the building through the ventilation system		4777

6.6104.1 Outdoor Supply Air Handling Unit Serving Multiple Dwelling Units or Corridors (All Building Types)

Topic: Supply

Subtopic: Supply Ventilation Systems

Desired Outcome: Air handling unit system installed to provide required ventilation

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

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
6.6104.1a Pre-inspection	Specifications will be field verified as appropriate to site conditions by installer	Ensure appropriate design for installation		4778
6.6104.1b Air flow	ASHRAE 62.2 and local code requirements should be followed for identifying design airflow rates within apartment dwelling units. All other areas will follow local code requirements and/or ASHRAE 62.1 requirements Air flows will be measured in accordance with ANSI/ACCA Standard 5 or ANSI/ASHRAE Standard 111 and adjusted to meet design requirements	Provide sufficient outdoor air to desired locations		4779
6.6104.1c Fan specification	Motors 1 horsepower or larger will meet NEMA premium efficiency standards Fan will be capable of maintaining a minimum operating static pressure of .25 inches of water column	Ensure proper flow rate of outdoor air fans Ensure energy efficient delivery of outdoor supply air		4780
6.6104.1d Intake location	Intake will be installed in accordance with all applicable code requirements and/or the most current version of ASHRAE 62.2	Ensure occupant health and safety Prevent entry of contaminants Ensure unrestricted airflow		4781
6.6104.1e Intake fitting	Intake fitting will have an integrated collar at least the same diameter as the duct Fitting will be appropriate for regional weather conditions and installation location on exterior of building	Effectively draw the required volume of air from outside Preserve integrity of the building envelope Ensure durable installation		4782
6.6104.1f Weatherproofing	Exterior termination fitting will be flashed or weather sealed	Prevent entry of weather into building shell		4783

	Water will be directed away from penetration Weatherproofing will be in accordance with manufacturer specifications			
6.6104.1g Pest exclusion	Screen material no less than 1/4" and no greater than 1/2" hole size in any direction will be used	Prevent entry of pests into building shell		4784
6.6104.1h Damper (if applicable)	Damper will close when system is off Damper will be installed to open in the direction of the desired flow	Ensure unrestricted air flow Prevent unintended airflow		4785
6.6104.1i Wiring	Wiring will be installed by a licensed contractor Wiring will be installed in accordance with original equipment manufacturer (OEM) specifications, and local and national electrical and mechanical codes Refer to NFPA 70: National Electrical Code for installation requirements.	Prevent an electrical hazard		4786
6.6104.1j Access	Fan, service switch, filter, and conditioning coils will be accessible for cleaning, maintenance, and repair	Allow for maintenance or replacement		4787
6.6104.1k Outdoor/fresh air makeup air handling unit mounting	Air handling unit outlet will be oriented toward the final termination location Air handling unit will be oriented so the equivalent length of the duct run is as short as possible Air handling unit will be mounted securely in accordance with manufacturer specifications and local code requirements (in terms of seismic restraints) Air handling unit will be isolated from the building framing unless specifically designed to be directly attached	Ensure short duct runs to achieve optimum air flows Ensure mounting is installed securely Ensure air handling unit housing or building framing does not shake, rattle, or hum when operating Minimize noise		4788
6.6104.1l Air handling unit/duct riser connection	Duct will be sealed to the top of the curb (for roof-mounted systems) Ductwork will be attached via a flexible connection, and will be installed in accordance with OEM and duct design minimum sizing requirements	Provide the most efficient air transfer from outdoor air to supply termination Prevent noise and vibration		4789

6.6104.1m Duct connections	All ducts, including intake fitting, will be connected and sealed in accordance with supply duct sealing	Deliver outdoor air to desired locations		4790
6.6104.1n Insulation	All components outside of the thermal envelope will be insulated to a minimum of R-8 or equivalent to local codes All exposed ductwork outside of the building will be insulated to a minimum R-12, protected from weather exposure, and sealed at all penetrations into building shell	Preserve integrity of the duct system Prevent heat and energy loss Prevent condensation in ductwork		4791
6.6104.1o Register boot to interior surface seal	Register boot will be sealed to interior surfaces with sealants compatible to their intended surfaces Sealants will be continuous and meet fire barrier specifications	Prevent air leakage around boot Ensure a permanent seal to the building air barrier Prevent a fire hazard		4792
6.6104.1p Preventing air leakage caused by air pressure differences between spaces	Walls, ceilings, and floors will be sealed to separate any occupied space from any unconditioned spaces and adjacent dwelling units Refer to ASHRAE 62.2 Addendum J If system design calls for supply air to enter dwelling units from pressurized corridor to under the door, then door will not be weatherstripped	Ensure occupant health and safety Prevent unintentional air leakage into the building and dwelling units from other spaces (e.g., adjacent dwelling units, garages, unconditioned crawl spaces, unconditioned attics)		4793
6.6104.1q Balance and flow	Air flows will be measured and adjusted in accordance with ANSI/ACCA Standard 5 or ANSI/ASHRAE Standard 111 and documented to meet design requirements	Achieve the desired air flows to and from the desired locations		4794
6.6104.1r Fire dampers	Fire dampers must be accessible for inspection and/or testing by the local authorities; if fire dampers are not accessible from a grill or register, an access door in the ductwork is required Sealing activities will not interfere with the operation of fire dampers, balancing dampers, or backdraft dampers Type B fire dampers will be used as required by fire code	Ensure access to fire dampers for safe operation Minimize static pressure Maximize air flow		4795

6.6104.1s Occupant/property manager education	Intake fitting will be labeled "ventilation air intake" Occupant/property manager will be instructed on purpose and value of system, and instructed to keep underside of door unobstructed (in pressurized corridor designs) Property manager will be instructed on the maintenance and procedures of maintaining system	Ensure unrestricted air flow Ensure the durability of the ventilation system		4796

6.6104.2 Outdoor Intake to Forced Air System—One System per Dwelling (All Building Types)

Topic: Supply

Subtopic: Supply Ventilation Systems

Desired Outcome: Intake reduces pollutant entry, is easily maintained, has proper flow, and enhances building durability

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

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
6.6104.2a Forced air system	Specifications will be field verified as appropriate to site conditions by installer Forced air system will be appropriately sized to handle latent and sensible loads of dwelling unit with the addition of conditioned or unconditioned outside ventilation air The manufacturer's temperature rise shall be maintained Forced air system duct leakage will be less than 10% of the air handler design flow when measured at 25 pascals	Reduce migration of pollutants from unconditioned spaces		4797
6.6104.2b Wiring	Wiring will be installed by a licensed contractor Wiring will be installed in accordance with original equipment manufacturer specifications, and local and national electrical and mechanical codes	Prevent an electrical hazard		4798

	Refer to NFPA 70: National Electrical Code for installation requirements.			
6.6104.2c Intake location	Intake will be installed in accordance with all applicable code requirements and/or the most current version of ASHRAE 62.2	Ensure occupant health and safety Prevent entry of contaminants Ensure unrestricted air flow		4799
6.6104.2d Mounting intake duct	Outdoor air ventilation duct will be attached as close to the return side of the heating, ventilation, and air conditioning (HVAC) system's circulating fan as possible while remaining in compliance with manufacturer temperature rise specifications Filtration of ventilation air will be provided before reaching the HVAC fan Duct will be connected to intake fitting Connection and seal will be performed in accordance with supply duct detail	Ensure short duct run to achieve optimum air flow Preserve integrity of the duct system and building envelope		4800
6.6104.2e Insulation	All duct components from outdoor intake to the air handler cabinet will be insulated to minimum R-8	Minimize energy loss Prevent condensation		4801
6.6104.2f Access	Motorized damper and service switch will be accessible for maintenance	Ensure accessibility for maintenance		4802
6.6104.2g Motorized damper	A motorized damper or equivalent technology will be installed between the outdoor air intake fitting and the return side of the air handler circulating fan Outdoor air flow will be provided by scheduled operation of the damper or equivalent technology Damper will be open only when the air handler fan is operating	Prevent air flow when none is desired		4803
6.6104.2h Verification	Outdoor air intake flow rates will be measured and documented to meet design requirements Proper operation and calibration of controls and damper sequencing will be verified by installer	Ensure the performance of the ventilation system Ensure occupant health and safety		4804
6.6104.2i Fire dampers	Fire dampers must be accessible for inspection and/or testing by the local authorities; if fire dampers are not accessible from a	Ensure access to fire dampers for safe operation Minimize static pressure Maximize air flow		4805

	grill or register, an access door in the ductwork is required Sealing activities will not interfere with the operation of fire dampers, balancing dampers, or backdraft dampers Type B fire dampers will be used as required by fire code			
6.6104.2j Occupant/property manager education	Occupant/property manager will be educated on the purpose of the system and how it works	Ensure the system is not unintentionally disabled		4806

6.6201.3 Primary Ventilation Air Flow Between Rooms

Topic: Whole Building Ventilation

Subtopic: Air Flow Requirements

Desired Outcome: Air circulates freely between rooms

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
6.6201.3a Balancing pressure	An appropriate means of pressure balancing will be installed (e.g., transfer grilles, jumper ducts, individual room returns) No room will exceed +/- 3 pascals with reference to the outside with all interior doors closed and ventilation systems running Return airflow paths for residential space shall be designed in accordance with ANSI/ACCA 1 Manual D or equivalent Ducts for common areas shall be designed in accordance with ASHRAE procedures or ACCA Manual Q	Ensure free flow of air between rooms Preserve integrity of the building envelope		4807

6.6201.4 Balancing—Makeup/Outside Air (All Building Types)

Topic: Whole Building Ventilation

Subtopic: Air Flow Requirements

Desired Outcome: Ventilation equipment operates as designed

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
6.6201.4a Validate air	System will be checked for existence of specified system components	Confirm installed system Familiarize with system components		4808

distribution system installation		Verify system readiness for testing		
6.6201.4b Testing equipment selection	Measurement equipment will be selected so that design value will be within the accurate range of the measuring device Equipment will be capable of accurately measuring +/- 10% in general case If design flow is less than 100 cubic feet per minute (CFM), equipment will be capable of accurately measuring down to 10 CFM (+/- 5%) Static pressures will be measured using manometers capable of measuring +/- 1 pascal Measurement equipment will be calibrated and field checked in accordance with manufacturer recommendations	Ensure accurate measurements of ventilation rates		4809
6.6201.4c Test main fan or air handler unit	Equipment testing will check for: • Proper operation (programmed schedule/sequence of operation) • Proper rotation • Filter condition • Total flow at fan Air flows will be measured in accordance with ANSI/ACCA Standard 5 or ANSI/ASHRAE Standard 111; all measured values will be recorded and compared against design specifications Fan flow will be adjusted to meet design specification	Verify performance of air handler system		4810
6.6201.4d Measure air flow and static pressure at terminals	Air flow and static pressure will be measured and recorded Measurements will be taken with terminals as found, with no adjustments made to the grille fins All measured values will be recorded and compared against design specifications The terminal with the lowest flow will be identified and recorded	Verify distribution system Identify potential adjustments Establish baseline air flow rates		4811
6.6201.4e Adjustment of system	Adjustments will be made to fan speed, dampers, and registers until design specifications are met	Balance system utilizing least resistance and energy		4812

6.6201.4f Final balance	Final air flow and/or pressure will be measured, confirmed, and recorded at fan and terminals	Provide acceptable thermal comfort, energy efficiency, and indoor air quality		4813
6.6201.4g Occupant/property manager education	Occupant/property manager will be: • Instructed on proper operation and maintenance procedures • Educated on value and need for recommissioning requirements Property manager will complete a 30-hour OSHA safety education course	Ensure continued operation of equipment at design performance levels		4814

6.6202.3 Airflow Control Devices (All Building Types)

Topic: Whole Building Ventilation

Subtopic: Components

Desired Outcome: Efficient and balanced distribution system

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
6.6202.3a Pre-inspection	Specifications will be field verified as appropriate to site conditions by installer (e.g., duct size, type, shape, register type, duct static pressure) Access to all dwelling units and elements of distribution system will be ensured by installer	Ensure appropriate design for installation		4815
6.6202.3b Preparation	Duct cleaning, when performed, will be performed in compliance with ANSI / ACCA 6 HVAC System Cleanliness Register cleaning or replacement will be performed as specified Duct sealing will be performed as specified Stack pressures will be verified for proper operation of flow control device Presence and type of dampers and smoke control devices will be identified, and installer will ensure the installation of the air flow device will not interfere with	Establish preconditions for installing flow control device Ensure health and safety of occupant		4816

	proper operation			
6.6202.3c Material selection	Appropriate selection of air flow regulator or orifice will be confirmed by installer; if custom design is required, it will be determined by installer Registers will be compatible with selected flow control device Gasketing or transition system will be compatible with selected flow control device and existing duct components Sealants and materials will be compatible with their intended surfaces and applied in accordance with manufacturer specifications Duct sealants will be UL 181 compliant Sealants and materials will be continuous and in accordance with fire barrier specifications	Ensure sealants and materials meet or exceed the performance characteristics required of the assembly (e.g., fire rating) Ensure conditions exist for effective installation of flow control device Ensure conditions exist for the flow control device to meet the design specifications		4817
6.6202.3d Installation	Transition or adapter will be securely fastened and sealed in accordance with manufacturer specifications Flow control device will be installed with proper orientation and in accordance with manufacturer specifications Adjustable devices will be set to preliminary balancing position	Achieve specified design flows Provide a durable and secure installation		4818
6.6202.3e Balance and flow	Air flows will be measured and adjusted to match to the design specification in accordance with ANSI/ACCA Standard 5 or ANSI/ASHRAE Standard 111	Achieve the desired air flows to and from the desired locations		4819
6.6202.3f Verification	Final visual inspection of flow control installation and installer documentation will be completed Continued operation of dampers and smoke control devices will be verified	Ensure the performance of the ventilation system Ensure occupant health and safety		4820
6.6202.3g Occupant/property manager education	Occupant/property manager will be educated on how the system works and its purpose Occupant/property manager will be educated on how to inspect flow control device upon unit turnover	Ensure the durability of the ventilation system		4821

6.6202.4 Operational Controls

Topic: Whole Building Ventilation

Subtopic: Components

Desired Outcome: Fan controls support ventilation strategy

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

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
6.6202.4a Primary ventilation fan	Specifications will be field verified as appropriate to site conditions by installer Controls will be used that can meet the following conditions: • Run fan continuously or intermittently, depending upon the intended schedule of operation • Operate fan to produce the intended flow for each intended flow setting • Any switch for ventilation system will be labeled	Deliver intended air exchange Ensure fan controls meet intended ventilation strategy		4822
6.6202.4b Spot fan	Controls will be used that meet the following conditions: • Run fan continuously or intermittently, depending on the intended schedule of operation • Run fan for intended time for timed operation • Operate fan to produce the intended flow for each intended flow setting	Deliver intended air exchange Ensure fan controls meet intended ventilation strategy		4823
6.6202.4c Wiring	Wiring will be installed by a properly licensed contractor Wiring will be installed in accordance with original equipment manufacturer specifications, and local and national electrical and mechanical codes Refer to NFPA 70: National Electrical Code for installation requirements.	Prevent an electrical hazard Ensure fan controls meet intended ventilation strategy		4824

6.6202.4d Occupancy sensors/humidistat	Manual override will be present on all controls Occupancy sensor and/or humidistat will be calibrated and commissioned effectively, and on a maintenance schedule Manufacturer specifications will be followed	Allow occupant control Ensure fan controls meet intended ventilation strategy Maintain performance of control device		4825
6.6202.4e Carbon dioxide sensors (demand control)	Multispeed or variable frequency drive fan will be required Sensors will be calibrated and commissioned effectively, and on a maintenance schedule Manufacturer specifications will be followed	Ensure fan controls meet intended ventilation strategy Maintain performance of control device		4826
6.6202.4f Occupant/property manager education	When fan controls are present and controlled by occupant, a system operation guide designed for occupants (nonprofessionals) will be provided to explain how and why to operate system Every six months, maintenance staff will verify timer systems are in place and are operating properly	Educate occupants about system operation and importance Deliver intended air exchange		4827

6.6202.5 Heat Recovery Ventilator and Energy Recovery Ventilator Installation serving Multiple Dwelling Units (All Building Types)

Topic: Whole Building Ventilation

Subtopic: Components

Desired Outcome: Heat Recovery Ventilator (*HRV*) and Energy Recovery Ventilator (*ERV*) systems installed to specifications

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

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
6.6202.5a Equipment specification	Specifications will be field verified as appropriate to site conditions by installer	Ensure appropriate equipment is specified Ensure design and installation are feasible		4828
6.6202.5b Air flow	ASHRAE 62.2 and local code requirements should be followed for identifying design airflow rates within apartment dwelling units; all other areas will follow local	Provide sufficient outdoor air to desired locations		4829

	code requirements and/or ASHRAE 62.1 requirements Air flows will be measured in accordance with ANSI/ACCA Standard 5 or ANSI/ASHRAE Standard 111 and adjusted to meet design requirements			
6.6202.5c Wiring	Wiring will be installed by a licensed contractor Wiring will be installed in accordance with original equipment manufacturer specifications, and local and national electrical and mechanical codes Refer to NFPA 70: National Electrical Code for installation requirements.	Prevent an electrical hazard		4830
6.6202.5d Access	Fans, service switch, filters, drain, and drain pan will be accessible for maintenance or replacement	Maintain designed air flows and system performance Ensure occupant health and safety		4831
6.6202.5e HRV/ERV mounting	HRV/ERV will be mounted securely in accordance with manufacturer specifications and local code requirements (in terms of seismic restraints) HRV/ERV will be oriented so the equivalent length of the duct run is as short as possible HRV/ERV will be isolated from the building framing unless specifically designed to be directly attached	Ensure short duct runs achieve optimum air flows Ensure HRV/ERV is mounted securely Ensure HRV/ERV housing or building framing does not shake, rattle, or hum when operating Minimize noise		4832
6.6202.5f Condensate drain	Condensation shall be drained to a location approved by the local jurisdiction	Prevent moisture problems		4833
6.6202.5g New connecting ductwork	All exposed ductwork outside of the building will be insulated to a minimum R-12, protected from weather exposure, and sealed at all penetrations into building shell	Ensure durability and energy efficiency of ductwork		4834
6.6202.5h Distribution systems	Note: HRV/ERV provides the outdoor air supply fan and the exhaust fan The rest of the ventilation system will be installed in accordance with the following details: • SWS 6.6104.1 Outdoor Supply Air Handling Unit	Achieve the desired air flows to and from the desired locations Preserve integrity of the duct system and building envelope		4835

	Serving Multiple Dwelling Units or Corridors) • SWS 6.6004.1 Central/Common Exhaust Fan Serving Multiple Dwelling Units via Common Duct(s) and Dwelling Unit Branches			
6.6202.5i Fire dampers	Fire dampers must be accessible for inspection and/or testing by the local authorities; if fire dampers are not accessible from a grill or register, an access door in the ductwork is required Sealing activities will not interfere with the operation of fire dampers, balancing dampers, or backdraft dampers Type B fire dampers will be used as required by fire code	Ensure access to fire dampers for safe operation Minimize static pressure Maximize air flow		4836
6.6202.5j Occupant/property manager education	Occupant/property manager will be educated on purpose of system, and how and when to change filter and clean drain pan, if applicable, in accordance with manufacturer specifications	Ensure occupant health and safety Preserve integrity of system		4837

6.6202.6 Heat Recovery Ventilator and Energy Recovery Ventilator Installation in Single Dwelling Unit (All Building Types)

Topic: Whole Building Ventilation

Subtopic: Components

Desired Outcome: Heat Recovery Ventilator (*HRV*) and Energy Recovery Ventilator (*ERV*) systems installed to specifications

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

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
6.6202.6a Equipment specifications	Specifications will be field verified as appropriate to site conditions by installer	Ensure appropriate equipment is specified Ensure design and installation are feasible		4838
6.6202.6b Air flow	ASHRAE 62.2 and local code requirements should be followed	Provide sufficient outdoor air to desired locations		4839

	for identifying design airflow rates within apartment dwelling units. All other areas will follow local code requirements and/or ASHRAE 62.1 requirements Air flows will be measured in accordance with ANSI/ACCA Standard 5 or ANSI/ASHRAE Standard 111 and adjusted to meet design requirements			
6.6202.6c Wiring	Wiring will be installed by a properly licensed contractor Wiring will be installed in accordance with original equipment manufacturer specifications, and local and national electrical and mechanical codes Refer to NFPA 70: National Electrical Code for installation requirements	Prevent an electrical hazard		4840
6.6202.6d Access	Fans, service switch, filters, drain, and drain pan will be accessible for maintenance or replacement	Maintain designed air flows and system performance Ensure occupant health and safety		4841
6.6202.6e HRV/ERV mounting	Fan will be mounted securely in accordance with manufacturer specifications and local code requirements (in terms of seismic restraints) Fan will be oriented so the equivalent length of the duct run is as short as possible Fan will be isolated from the building framing unless specifically designed to be directly attached	Ensure short duct runs achieve optimum air flows Ensure fan is mounted securely Ensure fan housing or building framing does not shake, rattle, or hum when operating Minimize noise		4842
6.6202.6f Condensate drain	Condensation shall be drained to a location approved by the local jurisdiction	Prevent moisture problems		4843
6.6202.6g Backdraft dampers (required for intermittent operation)	A backdraft damper will be installed between the HRV or ERV and the exterior, unless the system operates continuously	Prevent reverse air flow when the system is off		4844
6.6202.6h Fan outlet termination	Minimum distance of exhaust outlet from any doors, windows, or outside air intakes shall be in conformance with the applicable building code	Direct exhaust to the outdoors and prevent re-entry Prevent entry of weather and pests into building shell		4845

	Outlet will be sealed to prevent water intrusion and exhaust air leakage into building cavities	Ensure occupant health and safety		
6.6202.6i Intake location	Intake will be installed in accordance with the following: • A minimum of 6" above grade • A minimum of 10' from contaminant sources • Above local snow or flood line • A minimum of 18" above an asphalt-based roof Minimum distance between exhaust outlet and air intake will be 6' or in accordance with manufacturer specifications	Ensure occupant health and safety Prevent entry of contaminants Ensure unrestricted airflow		4846
6.6202.6j Intake/exhaust fitting	Intake/exhaust fitting will have integrated collar that is at least the same diameter as the duct Fitting will be appropriate for regional weather conditions and installation location on exterior of building	Effectively draw the required volume of air from outside Preserve integrity of the building envelope Ensure durable installation		4847
6.6202.6k Weatherproofing	Exterior termination fittings will be flashed or weather sealed Water will be directed away from penetration Weatherproofing will be in accordance with manufacturer specifications	Prevent entry of weather into building shell		4848
6.6202.6l Pest exclusion	Screen material no less than 1/4" and no greater than 1/2" hole size in any direction will be used at any exhaust and intake	Prevent entry of pests into building shell		4849
6.6202.6m Duct connections	Ducts will be connected to applicable registers or grilles, collector box, HRV or ERV, intake fitting, and termination fitting Ducts will be connected and sealed in accordance with duct exhaust and supply duct detail	Achieve the desired air flows to and from the desired locations Preserve integrity of the duct system and building envelope		4850
6.6202.6n Duct layout for attachment to forced air systems	Exhaust air will not be taken from the forced air system Outdoor air supply ducts attached to the return side of forced air systems will be: • Attached as close to the heating, ventilation, and	Achieve the desired air flows to and from the desired locations Preserve integrity of duct system and building Ensure occupant health and safety		4851

	air conditioning (HVAC) system's fan as possible, while remaining in compliance with manufacturer specifications • Connected to the outdoor air outlet from HRV/ERV system • Filtration of ventilation air will be provided before reaching the HVAC fan • Connected and sealed in accordance with the supply duct detail			
6.6202.6o Duct layout for fully ducted HRV/ERV systems	All ducts will be connected and sealed in accordance with SWS 6.6004.2 Individual Exhaust Fan Serving Multiple Rooms Within a Single Dwelling Unit and SWS 6.6102.7 Ducts for Supply	Achieve the desired air flows to and from the desired locations Preserve integrity of duct system and building Ensure occupant health and safety		4852
6.6202.6p Insulation	Outdoor air intake duct will be insulated from the outdoor air intake to the HRV/ERV system to a minimum of R-8 or equivalent to local codes Ducts installed outside of the thermal envelope will be insulated to a minimum of R-8 or equivalent to local codes	Preserve integrity of the duct system by eliminating condensation		4853
6.6202.6q Register boot to interior surface seal	Register boot will be sealed to interior surfaces with sealants compatible to their intended surfaces Sealants will be continuous and meet fire barrier specifications	Prevent air leakage around boot Ensure a permanent seal to the building air barrier Prevent a fire hazard		4854
6.6202.6r Sealant selection	Sealants will be compatible with their intended surfaces Sealants will be continuous and meet fire barrier specifications	Ensure a permanent seal Prevent a fire hazard		4855
6.6202.6s Balance and flow	Air flows will be measured in accordance with ANSI/ACCA Standard 5 or ANSI/ASHRAE Standard 111 and adjusted to match to the design specification	Achieve the desired air flows to and from the desired locations		4856
6.6202.6t Fire dampers	Fire dampers must be accessible for inspection and/or testing by the local authorities; if fire dampers are not accessible from a grill or	Ensure access to fire dampers for safe operation Minimize static pressure Maximize air flow		4857

	register, an access door in the ductwork is required Sealing activities will not interfere with the operation of fire dampers, balancing dampers, or backdraft dampers Type B fire dampers will be used as required by fire code			
6.6202.6u Occupant/property manager education	Occupant/property manager will be educated on purpose of system, and also how and when to change filter and clean drain pan, if applicable, in accordance with manufacturer specifications	Ensure occupant health and safety Preserve integrity of system		4858

6.6202.7 Installation and Control of Variable Frequency Drives on Fans

Topic: Whole Building Ventilation

Subtopic: Components

Desired Outcome: Improved fan efficiency and control

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
6.6202.7a Evaluate existing fans, motors, and ventilation system	Motors will be evaluated to determine compatibility with variable frequency drive (VFD) Load profile and source equipment will be analyzed for use of VFD to provide variable ventilation rates Control strategy will be determined (e.g., manually adjusted speed or remote sensor control)	Ensure existing motors and ventilation system are compatible with VFD operation		4859
6.6202.7b Remove and replace motor, if required	Power supply will be disconnected; existing motor will be removed and replaced with motor suitable for VFD operation	Provide motor suitable for VFD operation		4860
6.6202.7c Remove motor starter and replace with VFD	Power supply will be disconnected; existing starter will be replaced with VFD in accordance with manufacturer specifications	Install and connect VFD		4861
6.6202.7d Install required sensors to	Feedback sensors will be installed in accordance with manufacturer specifications at locations that will optimize chosen control strategy	Ensure sensors are installed to optimize VFD operation		4862

implement VFD control strategy (for sensor controlled strategies)	Feedback sensors will be wired to VFD in accordance with manufacturer specifications			
6.6202.7e Install required manual controls to implement VFD control strategy (for sensor and/or manual controlled strategies)	Speed controls will be installed in accordance with manufacturer specifications at a location for ease of continued operation	Ensure manual controls are installed to optimize VFD operation, and for ease of installer and continuous operation		4863
6.6102.7f Restore power supply to VFD, and verify operation of VFD and fan	Power supply will be restored VFD will be shown to be capable of operating fan VFD will be shown to be capable of receiving sensor signals	Ensure that VFD is ready for setup		4864
6.6101.7g Initial setup of VFD	VFD parameters will be set up to accept feedback from sensors dependent upon chosen control strategy System will be optimized to ensure targeted design ventilation rates at the lowest possible speed setting	Achieve targeted design ventilation requirements with reduced electrical energy use		4865

6.6202.8 Replacement of Conventional Fans with Electrically Commutated Motor-Driven Fans

Topic: Whole Building Ventilation

Subtopic: Components

For supporting material, see Building America Solution Center.

Desired Outcome: Improved fan efficiency and control

TITLE	SPECIFICATION(S)	OBJECTIVE(S)	

6.6202.8a Evaluate existing fans, motors, and ventilation system	Control strategy will be determined (e.g., manually adjusted motor-mounted speed control, manually adjusted remote speed control, static pressure sensor control)	Ensure existing ventilation system is compatible with electrically commutated motor (ECM) operation		4866
6.6202.8b Check for presence of asbestos-containing materials (ACMs)	Potential ACMs will be handled in accordance with SWS 2.0110.2 Potential Asbestos-Containing Materials	Ensure safe work environment		4867
6.6202.8c Remove and replace existing fan with ECM fan	Existing fan will be removed and replaced with ECM fan, installed in accordance with manufacturer specifications	Ensure proper operation of ECM fan		4868
6.6202.8d Install required sensors to implement ECM control strategy (for sensor controlled strategies)	Feedback sensors will be installed in accordance with manufacturer specifications at locations that will optimize chosen control strategy Feedback sensors will be wired to ECM in accordance with manufacturer specifications	Ensure sensors are installed to optimize ECM operation		4869
6.6202.8e Install required manual controls to implement ECM control strategy (for sensor and/or manual controlled strategies)	Speed controls will be installed in accordance with manufacturer specifications at a location optimized for ease of continued operation	Ensure manual controls are installed to optimize ECM operation, and for ease of installer and continuous operation		4870
6.6202.8f Restore	Power supply will be restored	Ensure that ECM is ready for setup		4871

power supply to variable frequency drive, and verify operation of ECM and fan	ECM will be shown to be capable of operating the fan ECM will be shown to be capable of receiving sensor signals, when applicable			
6.6202.8g Initial setup of ECM	ECM parameters will be set up to accept feedback from sensors dependent upon chosen control strategy System will be optimized to ensure targeted design ventilation rates at the lowest possible speed setting	Achieve targeted design ventilation requirements with reduced electrical energy use		4872

6.6202.9 Filtration for Fan-Powered (Active) Systems

Topic: Whole Building Ventilation

Subtopic: Components

Desired Outcome: Indoor air quality (*IAQ*) improved and equipment efficiency maintained

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
6.6202.9a Pre-inspection	Specifications will be field verified as appropriate to site conditions by installer	Ensure appropriate design for installation		4873
6.6202.9b Selection	All mechanically supplied outdoor air will pass through filter before conditioning Filters and filter racks/holders will have a rating of minimum efficiency rating value 6 or higher when tested in accordance with ASHRAE 52.2 Pressure drop across filter will match equipment capabilities Filter systems that produce ozone will not be allowed	Ensure outdoor air is filtered before entering occupied space Ensure occupant health and safety		4874
6.6202.9c Installation	Filter will be located and installed to facilitate access and regular service by occupant/maintenance staff Filter will be located on the inlet side of the equipment fan Filter access panel will include gasket or comparable sealing mechanism and fit snugly against	Prevent air bypass of filter Allow for proper maintenance and replacement		4875

	exposed edge of filter when closed to prevent air bypass Filter plenum construction will be airtight and sealed to adjoining ductwork			
6.6202.9d Occupant/property manager education	Occupant/property manager will be instructed on proper maintenance procedures and replacement schedule	Ensure continued performance of equipment efficiency and IAQ		4876

6.6203.2 Dehumidifying Ventilator Serving Multiple Dwelling Units (All Building Types)

Topic: Whole Building Ventilation

Subtopic: Dehumidifiers

Desired Outcome: Humidity controlled to achieve optimum indoor air quality (*IAQ*)

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

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
6.6203.2a Equipment specification	Specifications will be field verified as appropriate to site conditions by installer Equipment will be ENERGY STAR® qualified (where applicable) Settings will be maintained through power failure (auto restart) Dehumidification ventilator will be a ducted unit Dehumidification ventilator will be able to provide outside air	Efficiently remove humidity Ensure ease of operation Provide ventilation with outside air Ensure appropriate equipment is specified Ensure design and installation are feasible		4877
6.6203.2b Sizing	System with enough capacity to handle humidity from outside air ventilation and internal gains will be selected Humidity levels inside the space will be maintained at less than 60% Note: As outdoor temperature drops, indoor humidity will need to be low enough to prevent condensation in building enclosure ASHRAE 62.2 and local code requirements should be followed for identifying design airflow rates within apartment dwelling units.	Efficiently remove humidity Provide sufficient outdoor air to desired locations Avoid moisture problems associated with over ventilation in a hot and humid climate		4878

	All other areas will follow local code requirements and/or ASHRAE 62.1 requirements Air flows will be measured in accordance with ANSI/ACCA Standard 5 or ANSI/ASHRAE Standard 111 and adjusted to meet design requirements			
6.6203.2c Access	Equipment will be located in an area with access to heating, ventilation, and air conditioning supply trunk line or plenum, outside air Fans, service switch, filters, drain, and drain pan will be accessible for maintenance or replacement	Easily maintain equipment Maintain designed air flows and system performance Ensure occupant health and safety		4879
6.6203.2d Installation	Installation will be in accordance with manufacturer specifications and local codes Dehumidifying ventilator will be mounted securely in accordance with manufacturer specifications and local code Requirements (in terms of seismic restraints) Dehumidifying ventilator will be oriented so the equivalent length of the duct run is as short as possible Dehumidifying ventilator will be isolated from the building framing unless specifically designed to be directly attached	Maintain manufacturer warranty and proper installation Ensure short duct runs achieve optimum air flows Ensure dehumidifying ventilator is mounted securely Ensure dehumidifying ventilator housing or building framing does not shake, rattle, or hum when operating Minimize noise		4880
6.6203.2e Controls	Operation of the dehumidifier will be based upon humidity/temperature in the return air, or provide supply air at a specified temperature and humidity	Ensure system operation controls the humidity		4881
6.6203.2f Wiring	Wiring will be installed by a licensed contractor Wiring will be installed in accordance with original equipment manufacturer specifications, and local and national electrical and mechanical codes Refer to NFPA 70: National Electrical Code for installation requirements	Prevent an electrical hazard		4882
6.6203.2g Condensate drain	Condensation shall be drained to a location approved by the local jurisdiction	Prevent moisture problems		4883
6.6203.2h New	All exposed ductwork outside of the building will be insulated to a minimum R-12, protected from	Ensure durability and energy efficiency of ductwork		4884

connecting ductwork	weather exposure and sealed at all penetrations into building shell All ductwork outside of conditioned space will be insulated to a minimum of R-8			
6.6203.2i Distribution systems	Note: Dehumidifying ventilator provides the outdoor air supply fan The rest of the ventilation system will be installed in accordance with SWS 6.6104.1 Outdoor Supply Air Handling Unit Serving Multiple Dwelling Units or Corridors (All Three Building Types)	Achieve the desired air flows to and from the desired locations Preserve integrity of the duct system and building envelope		4885
6.6203.2j Verification	Verification of the dehumidification unit and controls will be performed and documented	Ensure the performance of the ventilation system Ensure occupant health and safety		4886
6.6203.2k Fire dampers	Fire dampers must be accessible for inspection and/or testing by the local authorities; if fire dampers are not accessible from a grill or register, an access door in the ductwork is required Sealing activities will not interfere with the operation of fire dampers, balancing dampers, or backdraft dampers Type B fire dampers will be used as required by fire code	Ensure access to fire dampers for safe operation Minimize static pressure Maximize air flow		4887
6.6203.2l Property manager education	Property manager will be educated on purpose of system, and how and when to change filter and clean drain pan, if applicable, in accordance with manufacturer specifications	Ensure occupant health and safety Preserve integrity of system		4888

6.6203.3 Dehumidifying Ventilator Serving Single Dwelling or Special Use Space (All Building Types)

Topic: Whole Building Ventilation

Subtopic: Dehumidifiers

Desired Outcome: Humidity controlled to achieve optimum indoor air quality (*IAQ*)

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

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		

6.6203.3a Equipment specification	Specifications will be field verified as appropriate to site conditions by installer Equipment will be ENERGY STAR® qualified Settings will be maintained through power failure (auto restart) Dehumidification ventilator will be a ducted unit Dehumidification ventilator will be able to provide outside air	Efficiently remove humidity Ensure ease of operation Provide ventilation with outside air Ensure appropriate equipment is specified Ensure design and installation are feasible		4889
6.6203.3b Sizing	System with enough capacity to handle humidity from outside air ventilation and internal gains will be selected Humidity levels inside space will be maintained at less than 60% Note: As outdoor temperature drops, indoor humidity will need to be low enough to prevent condensation in building enclosure ASHRAE 62.2 and local code requirements should be followed for identifying design airflow rates within apartment dwelling units. All other areas will follow local code requirements and/or ASHRAE 62.1 requirements Air flows will be measured in accordance with ANSI/ACCA Standard 5 or ANSI/ASHRAE Standard 111 and adjusted to meet design requirements	Efficiently remove humidity Provide sufficient outdoor air to desired locations Avoid moisture problems associated with over ventilation in a hot and humid climate		4890
6.6203.3c Access	Equipment will be located in an area with access to heating, ventilation, and air conditioning supply trunk line or plenum, outside air (where applicable) Fans, service switch, filters, drain, and drain pan will be accessible for maintenance or replacement	Easily maintain equipment Maintain designed air flows and system performance Ensure occupant health and safety		4891
6.6203.3d Installation	Installation will be in accordance with manufacturer specifications and local codes Dehumidifying ventilator will be mounted securely in accordance with manufacturer specifications and local code requirements (in terms of seismic restraints)	Maintain manufacturer warranty and proper installation Ensure short duct runs achieve optimum air flows Ensure dehumidifying ventilator is mounted securely Ensure dehumidifying ventilator housing or building framing does		4892

	Dehumidifying ventilator will be oriented so the equivalent length of the duct run is as short as possible Dehumidifying ventilator will be isolated from the building framing unless specifically designed to be directly attached	not shake, rattle, or hum when operating Minimize noise		
6.6203.3e Controls	Dehumidistat controls will be located near thermostat	Ensure system operation controls the humidity		4893
6.6203.3f Wiring	Wiring will be installed by a licensed contractor Wiring will be installed in accordance with original equipment manufacturer specifications, and local and national electrical and mechanical codes Refer to NFPA 70: National Electrical Code for installation requirements	Prevent an electrical hazard		4894
6.6203.3g Condensate drain	Condensation shall be drained to a location approved by the local jurisdiction	Prevent moisture problems		4895
6.6203.3h New connecting ductwork	All exposed ductwork outside of the building will be insulated to a minimum R-12, protected from weather exposure, and sealed at all penetrations into building shell All ductwork outside of conditioned space will be insulated to a minimum of R-8	Ensure durability and energy efficiency of ductwork		4896
6.6203.3i Distribution systems	Note: Dehumidifying ventilator provides the outdoor air supply fan The rest of the ventilation system will be installed in accordance with SWS 6.6202.6 Heat Recovery Ventilation and Energy Recovery Ventilator Installation in Single Dwelling Unit (note: exhaust side does not apply)	Achieve the desired air flows to and from the desired locations Preserve integrity of the duct system and building envelope		4897
6.6203.3j Verification	Verification of the dehumidification unit and controls will be performed and documented	Ensure the performance of the ventilation system Ensure occupant health and safety		4898
6.6203.3k Fire dampers	Fire dampers must be accessible for inspection and/or testing by the local authorities; if fire dampers are not accessible from a grill or	Ensure access to fire dampers for safe operation Minimize static pressure Maximize air flow		4899

	register, an access door in the ductwork is required Sealing activities will not interfere with the operation of fire dampers, balancing dampers, or backdraft dampers Type B fire dampers will be used as required by fire code			
6.6203.3l Occupant/property manager education	Occupant/property manager will be educated on purpose of system, and how and when to change filter and clean drain pan, if applicable, in accordance with manufacturer specifications	Ensure occupant health and safety Preserve integrity of system		4900

6.6207.1 Passive Ventilation (All Building Types)

Topic: Whole Building Ventilation

Subtopic: Passive Ventilation

Desired Outcome: Passive ventilation system installed to provide effective and efficient ventilation

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
6.6207.1a Pre-inspection	Specifications will be field verified as appropriate to site conditions by installer (e.g., presence of operating exhaust system, specified location, and type of trickle vent specifications) Access to all affected dwelling units will be ensured by installer	Ensure appropriate design for installation		4901
6.6207.1b Intake location	Intake will be installed in accordance with the following: • A minimum of 6" above grade • A minimum of 6' from exhaust outlets and will meet specifications of ASHRAE 62.1 Table 5-1 for all other contaminant sources • Above local snow or flood line • A minimum of 18" above an asphalt based roof	Ensure occupant health and safety Prevent entry of contaminants Ensure unrestricted air flow		4902
6.6207.1c Equipment selection	A system that provides a proper amount of air flow in accordance with ASHRAE 62.2 will be	Ensure proper equipment Ensure conditions for thermal comfort		4903

	selected that minimizes potential occupant discomfort and/or drafts			
6.6207.1d Material selection	Sealants and materials will be compatible with their intended surfaces and applied in accordance with manufacturer specifications Sealants and materials will be continuous and meet fire barrier specifications	Ensure sealants and materials meet or exceed the performance characteristics required of the assembly (e.g., fire rating)		4904
6.6207.1e Installation	Install in accordance with manufacturer specifications Inlet will be sealed to prevent water intrusion and air leakage into building cavities	Prevent entry of weather and pests into building shell Ensure occupant health and safety		4905
6.6207.1f Verification	Verification of the passive inlet device will be performed and documented Air will flow through the device in the correct direction Ventilation system operation will be tested to confirm it is not causing pressure imbalances Room-to-room pressure differential within the dwelling unit will be no greater than 3 pascals	Ensure the performance of the ventilation system Ensure occupant health and safety		4906
6.6207.1g Occupant/property manager education	Occupant/property manager will be educated on how the system works, and its purpose and value Occupant/property manager will be educated on how to inspect passive intake device upon unit turnover	Ensure the durability of the ventilation system		4907

6.6288.3 Regional Climatic Considerations

Topic: Whole Building Ventilation

Subtopic: Special Considerations

Desired Outcome: Regional climatic variables are taken into consideration

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
6.6288.3a Very cold	Energy recovery ventilators will not be installed in very cold climates unless they are equipped with frost controls A filter will be installed before heat recovery ventilator (HRV) Ventilation ducts will be insulated to a minimum of R-19	Prevent freezing of ventilator Ensure the ventilation system remains clean and operates properly Ensure condensation does not form on or in the ductwork		4908

6.6288.3b Hot humid	HRVs will not be installed Ventilation air intake will not be terminated at roof Determine whether net latent load from ventilation (both natural and mechanical) requires dehumidification; if so, install dehumidification. See SWS 6.6203.2 Dehumidifying Ventilator Serving Multiple Dweeling Unit (All Building Types) and SWS 6.6203.3 Dehumidifying Ventilator Serving Single Dwelling or Special Use Space (All Building Types)	Avoid low energy recovery equipment Prevent excessive heat entering ventilation air		4909

Section 7: Baseload

7.8001.3 Refrigerator and Freezer Replacement

Topic: Plug Load

Subtopic: Refrigerators/Freezers

Desired Outcome: Energy efficient appliance installed

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8001.3a Assessment	Unit and electrical receptacle will meet requirements of NFPA 70 Article 440	Determine and ensure appropriate device and location		4910
7.8001.3b Selection	Appliance shall be ENERGY STAR® rated Appliance will fit in the available space without blocking access to light switches, cabinets, etc. Appliance will carry a minimum 1-year warranty, which will provide a replacement appliance if repeated issues relating to health, safety, or performance occur	Reduce energy use Ensure device functions properly Ensure product safety Ensure occupant satisfaction		4911
7.8001.3c Installation	Appliance will be installed in accordance with manufacturer specifications and local codes Where applicable, appliance shall be accessible to the disabled as required by the Federal Fair Housing Act and ICC A117.1; the appliance shall not reduce required maneuvering clearances in the	Ensure worker safety Ensure occupant safety Ensure continued savings Achieve intended appliance function Preserve food at low energy use		4912

	kitchen to less than that permitted by the AHJ Any penetrations to the exterior created by the installation of the appliance will be sealed 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			
7.8001.3d Commissioning	Confirm appliance is operating in accordance with manufacturer specifications indicated in operation and maintenance manuals	Ensure occupant satisfaction Ensure occupant safety		4913
7.8001.3e Decommissioning	Appliances replaced by new units will be recycled or disposed of properly Appliances infested with pests will be enclosed before moving	Protect the environment Prevent the reuse of inefficient components		4914
7.8001.3f Safety	All OSHA standard practices will be followed	Ensure worker safety Ensure occupant safety		4915
7.8001.3g Staff education	Warranty information, operation manuals, and installer contact information will be provided to building operations staff	Educate building operations staff about operation and maintenance of equipment Ensure continued savings		4916
7.8001.3h Occupant education	Specific information on the proper maintenance of the equipment will be provided to the occupant	Educate occupants about appliance and benefits Ensure continued savings		4917

7.8002.2 Entertainment, and Computer Systems and Components Replacement

Topic: Plug Load

Subtopic: Electronics

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

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8002.2a Assessment	Unit and electrical receptacle will meet requirements of NFPA 70 Article 442	Determine and ensure appropriate device and location		4918
7.8002.2b Selection	Category of equipment selected will meet occupant preferences	Reduce energy use Ensure product safety		4919

	and have the lowest available energy use (e.g., plasma vs. light-emitting diode) Equipment will have a minimum energy-efficiency level of ENERGY STAR® Equipment will be selected that does not have to be left on during nonuse periods for updates (e.g., gaming systems, set-top boxes) Standby losses for system will be 1 watt or less	Ensure occupant satisfaction		
7.8002.2c 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 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	Ensure worker safety Ensure occupant safety Ensure continued savings Achieve intended appliance function		4920
7.8002.2d Commissioning	Confirm equipment is operating in accordance with manufacturer specifications indicated in operation and maintenance manuals	Ensure occupant satisfaction Ensure occupant safety		4921
7.8002.2e Decommissioning	Equipment will be recycled or disposed of using EPA Responsible Recycling (R2) initiative principles	Protect the environment Reduce waste Properly dispose of hazardous material Prevent the reuse of inefficient components		4922
7.8002.2f Safety	All OSHA standard practices will be followed	Ensure worker safety Ensure occupant safety		4923
7.8002.2g Staff education	Warranty information, operation manuals, and installer contact information will be provided to the building operations staff	Educate building operations staff about operation and maintenance of equipment Ensure continued savings		4924

	All equipment controls will be demonstrated to the building operations staff			
7.8002.2h Occupant education	Specific information on the proper maintenance of the equipment will be provided to the occupants All equipment controls will be demonstrated to the occupants	Educate occupants about appliance and benefits Ensure continued savings		4925

7.8003.10 Bi-Level Controls

Topic: Plug Load

Subtopic: Lighting

Desired Outcome: Energy used for lighting reduced

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

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8003.10a Assessment	Lighting strategy will be provided by lighting professional Safety and crime prevention will be considered as part of the strategy	Determine appropriate device, settings, and location Determine existing electrical conditions Prevent property damage Ensure occupant safety		4984
7.8003.10b Selection	Switches will be compatible with existing wiring Switches will meet the appropriate nationally recognized product standard	Reduce energy use Ensure device functions appropriately Ensure product safety Ensure multiple switching strategies can be used		4985
7.8003.10c Installation	Work will be performed by licensed electrical professional Switches will be installed in accordance with ANSI/NFPA 70, ANSI/NFPA 70E, and manufacturer specifications Switches will be positioned in a secure location and not subject to physical damage Labels will be permanently affixed without the use of adhesives near switch location to indicate light level and fixture control	Ensure worker safety Ensure occupant safety Prevent tampering Ensure continued savings Optimize system performance		4986
7.8003.10d Commissioning	Settings will be verified and tested to meet lighting design criteria	Optimize system performance Ensure occupant safety		4987

7.8003.10e Occupant safety	Switches will not compromise egress lighting, as required by ANSI/NFPA 101 Switches will not impact minimum light levels, as required by codes or local ordinances	Ensure occupant safety		4988
7.8003.10f Staff education	Building operations staff will be provided with warranty information, operation manuals, and installer contact information	Educate building operations staff about operation and maintenance of equipment Ensure continued savings		4989
7.8003.10g Occupant education	Occupants will be educated of new lighting controls and benefits Education will be provided by building operations staff	Educate occupants about new controls and benefits Ensure continued savings		4990

7.8003.11 Lamp Replacement

Topic: Plug Load

Subtopic: Lighting

Desired Outcome: Energy used for lighting reduced

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8003.11a Assessment	Lighting strategy will be provided by lighting professional Work order will be evaluated against site circumstances	Determine and ensure appropriate device and location		4991
7.8003.11b Selection	Lamps will be compatible with existing fixtures Lamps will meet the appropriate nationally recognized product standard (UL 542, UL 1570) Outdoor lamps will be suitable for local climate conditions and in accordance with ANSI / ULproduct standards Screw base lamp replacements will be ENERGY STAR® qualified or at least as energy efficient Compact fluorescent lamps and light emitting diode lamps will be ENERGY STAR qualified or at lease as energy efficient Linear fluorescent lamps will not be replaced with a T12, and T8 lamps will be minimum standard installed	Reduce energy use Ensure device functions properly Ensure product safety Ensure occupant satisfaction		4992

	Vandal-proof pin-based lamps will be used, if appropriate			
7.8003.11c Installation	Fixture will be de-energized before beginning work Worker will follow appropriate lockout procedures in accordance with OSHA 1910 Subpart S and ANSI/NFPA 70E Lamps will be installed in accordance with manufacturer specifications If fixture is broken, worker will refer to SWS 7.8003.14 Fixture Replacement Lens and reflector will be cleaned	Ensure worker safety Ensure occupant safety Ensure continued savings Optimize fixture performance		4993
7.8003.11d Commissioning	Relamping will be tested to meet IESNA protocol for appropriate light levels for certain tasks and emergency levels, as required by the applicable code Lamps will not impact required egress lighting, as required by ANSI/NFPA 101	Meet target light levels Ensure occupant satisfaction Ensure occupant safety		4994
7.8003.11e Decommissioning	Lamps will be disposed of in accordance with EPA guidelines, local ordinances, or manufacturer specifications	Protect the environment Prevent the reuse of inefficient components		4995
7.8003.11f Safety	Broken lamps containing mercury will be cleaned in accordance with EPA guidelines	Ensure worker safety Ensure occupant safety		4996
7.8003.11g Staff education	Building operations staff will be provided with warranty information, product specification, and installer contact information	Educate building operations staff about operation and maintenance of equipment Ensure continued savings		4997
7.8003.11h Occupant education	Occupants will be educated of new lamp type and benefits Occupant will be provided with lamp disposal procedure, as determined by building operations staff If lamps containing mercury are used, occupants will be provided with lamp disposal procedure in accordance with EPA guidelines Education will be provided by building operations staff	Educate occupants about new lamps and benefits Ensure continued savings Protect the environment Ensure occupant safety		4998

7.8003.12 Re- and Retro-Commissioning

Topic: Plug Load

Subtopic: Lighting

Desired Outcome: Energy efficiency of existing lighting controls maximized. (Re- means going through a commissioning process again; retro- means a first-time commissioning on an existing building)

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

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8003.12a Assessment	Lighting control optimization will be included as part of whole building re- or retro-commissioning Assessment will occur if lighting controls exist Lighting strategy will be provided by lighting professional in consultation with a licensed electrical professional Assessment will follow Lighting Controls Association EE110 and IES procedures (or appropriate section of ASHRAE's whole-building commissioning procedure)	Determine and ensure appropriate control settings		4999
7.8003.12b Adjustment	Adjustments will be made in accordance with lighting strategy	Optimize system performance		5000
7.8003.12c Safety	Controls will not compromise egress lighting, as required by ANSI/NFPA 101 and IBC Lighting controls will ensure that required egress light levels are maintained at times when the building is occupied and meet minimum light level requirements by codes or local ordinances Fixtures will be on when spaces are occupied	Ensure occupant safety		5001
7.8003.12d Staff education	Lighting professional will provide building operations staff with education on lighting control functions Lighting professional or installer will provide building operations staff with documentation on lighting control systems	Ensure continued savings		5002
7.8003.12e Occupant education	Occupants will be educated of new lighting controls and benefits Education will be provided by building operations staff	Educate occupants about new controls and benefits Ensure continued savings		5003

7.8003.13 Ballast Replacement

Topic: Plug Load

Subtopic: Lighting

Desired Outcome: Energy used for lighting reduced

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8003.13a Assessment	Lighting strategy will be provided by lighting professional Assessment will identify magnetic ballast location If the ballast is known to contain polychlorinated biphenyls (PCBs), does not have "No PCBs" on the ballast, or if the manufacturer cannot determine if the ballast contains PCBs, assume the ballast contains PCBs and dispose of ballast in an EPA-approved facility Work order will be evaluated against site circumstances	Determine and ensure appropriate device and location		5004
7.8003.13b Selection	Ballasts will be compatible with new or existing fixture Ballasts will meet the appropriate nationally recognized product standards (ANSI C82.1, ANSI C82.4, UL 924, UL 1029, NEMA) Pulse start, high-efficiency electronic ballast will be used Ballast factor will be a minimum of 0.85	Reduce energy use Ensure device functions appropriately Ensure product safety		5005
7.8003.13c Installation	Fixture will be de-energized before work begins Worker will follow appropriate lockout procedures in accordance with OSHA 1910 Subpart S and ANSI/NFPA 70E Ballasts will be installed in accordance with manufacturer specifications If fixture is broken, worker will refer to Fixture Replacement Standard Work Specifications, Section 7.8003.14. Lens and reflector will be cleaned	Ensure worker safety Ensure occupant safety Ensure continued savings Optimize fixture performance		5006

7.8003.13d Commissioning	Fixture will be tested to meet IESNA light levels for certain tasks Fixture will not impact required egress lighting, as required by ANSI/NFPA 101	Meet target light levels Ensure occupant satisfaction Ensure occupant safety		5007
7.8003.13e Decommissioning	Ballast manufacture date will be determined, if possible If the ballast is known to contain PCBs, does not have "No PCBs" on the ballast, or if the manufacturer cannot determine if the ballast contains PCBs, assume the ballast contains PCBs and dispose of ballast in an EPA-approved facility Ballasts manufactured in 1979 and after will be disposed of in accordance with local ordinances or manufacturer specifications Disposal manifests will be filed and available to building representatives	Protect the environment Prevent the reuse of inefficient components		5008
7.8003.13f Staff education	Building operations staff will be provided with warranty information, product specification, and installer contact information	Educate building operations staff about operation and maintenance of equipment Ensure continued savings		5009

7.8003.14 Fixture Replacement

Topic: Plug Load

Subtopic: Lighting

Desired Outcome: Energy used for lighting reduced

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

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8003.14a Assessment	Lighting strategy will be provided by lighting professional Work order will be evaluated against site circumstances	Determine and ensure appropriate device and location		5010
7.8003.14b Selection	Hard-wired indoor fixtures will be in accordance with ANSI/UL 1598 Plug-in indoor fixtures will be in accordance with ANSI/UL 153	Reduce energy use Ensure device functions appropriately Ensure product safety Ensure occupant safety		5011

	Hard-wired outdoor fixtures will be suitable for local climatic conditions and in accordance with ANSI/UL product standards Fixture will be capable of being attached to existing wiring Fixture will carry at least a 1-year warranty Test existing emergency fixtures and repair or replace if necessary In-unit replacement fixtures will be ENERGY STAR® qualified Fixture will comply with selection criteria of SWS 7.8003.11 Lamp Replacement and SWS 7.8003.13 Ballast Replacement			
7.8003.14c Installation	Work will be performed by licensed electrical professional or a qualified contractor Fixture will be de-energized before work begins Appropriate lockout procedures will be followed in accordance with OSHA 1910 Subpart S and ANSI/NFPA 70E Fixture will be installed in accordance with ANSI/NFPA 70, ANSI/NFPA 70E, and manufacturer specifications All penetrations will be sealed (ANSI/NFPA/ICC Fire Code) Egress fixtures will be installed in accordance with applicable codes (NFPA 101) Lighting fixtures will be installed and secured as specified NECA/IESNA 500	Ensure worker safety Ensure occupant safety Preserve integrity of building envelope Ensure integrity of fire barrier Ensure quality installation		5012
7.8003.14d Commissioning	Fixtures will be tested to meet IESNA light levels for certain tasks Fixtures will not impact required egress lighting, as required by ANSI/NFPA 101	Meet target light levels Ensure occupant satisfaction Ensure occupant safety		5013
7.8003.14e Decommissioning	Fixtures, lamps, and ballasts will be disposed of in accordance with local ordinances or manufacturer specifications Ballast manufacture date will be determined, if possible If the ballast is known to contain PCBs, does not have "No PCBs"	Protect the environment Prevent the reuse of inefficient components		5014

	on the ballast, or if the manufacturer cannot determine if the ballast contains PCBs, assume the ballast contains PCBs and dispose of ballast in an EPA-approved facility Ballasts manufactured in 1979 and after will be disposed of in accordance with local ordinances or manufacturer specifications			
7.8003.14f Safety	Broken lamps containing mercury will be cleaned in accordance with EPA guidelines	Ensure worker safety Ensure occupant safety		5015
7.8003.14g Staff education	Building operations staff will be provided with warranty information, product specification, and installer contact information	Educate building operations staff about operation and maintenance of equipment Ensure continued savings		5016
7.8003.14h Occupant education	Occupants will be educated on new fixtures and benefits Occupants will be provided with lamp disposal procedure, as determined by building operations staff If lamps containing mercury are used, occupants will be provided with lamp disposal procedure in accordance with EPA guidelines Education will be provided by building operations staff	Educate occupants about new fixtures and benefits Ensure continued savings Protect the environment Ensure occupant safety		5017

7.8003.15 Security Lighting

Topic: Plug Load

Subtopic: Lighting

Desired Outcome: Energy used for lighting reduced

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8003.15a Assessment	Lighting strategy will be provided by lighting professional Work order will be evaluated against site circumstances	Determine and ensure appropriate device and location		5018
7.8003.15b Selection	Security light fixtures will meet the appropriate nationally recognized product standard (UL 542, UL 1570) Outdoor lamps will be suitable for local climate conditions and in	Reduce energy use Ensure device functions properly Ensure product safety Ensure occupant satisfaction Ensure adequate lighting during emergency situations		5019

	accordance with ANSI/UL product standards Security cameras will be considered Security lighting shall be configured to be switched off unless motion is detected Lighting shall remain on for no more than 30 minutes if continued motion is not detected Photo and motion sensors will be included Vandal proof fixtures will be used			
7.8003.15c Installation	Fixture will be de-energized before work begins Worker will follow appropriate lockout procedures in accordance with OSHA 1910 Subpart S and ANSI/NFPA 70E Lamps will be installed in accordance with manufacturer specifications If fixture is broken, worker will refer to SWS 7.8003.14 Fixture Replacement Lens and reflector will be cleaned	Ensure worker safety Ensure occupant safety Ensure continued savings Optimize fixture performance		5020
7.8003.15d Commissioning	Security lighting will be tested in accordance with local ordinances and manufacturer specifications To limit light pollution, aiming of light fixtures shall minimize light emitted above the horizontal Security lighting shall not shine light directly beyond the perimeter of the development, and shall not shine light directly into any window of any residence	Meet target light levels Ensure occupant satisfaction Ensure occupant safety		5021
7.8003.15e Decommissioning	Lamps will be disposed of in accordance with local ordinances or manufacturer specifications	Protect the environment Prevent the reuse of inefficient components		5022
7.8003.15f Safety	Broken lamps containing mercury will be cleaned in accordance with EPA guidelines	Ensure worker safety Ensure occupant safety		5023
7.8003.15g Staff education	Building operations staff will be provided with warranty information, product specification, and installer contact information	Educate building operations staff about operation and maintenance of equipment		5024
7.8003.15h Occupant education	Education regarding security lighting will be provided by building operations staff	Ensure occupant safety		5025

7.8003.2 Exit Sign Replacement

Topic: Plug Load

Subtopic: Lighting

Desired Outcome: Energy used for lighting reduced

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8003.2a Assessment	Lighting strategy will be developed to meet applicable life safety requirements (IBC 1011 or NFPA 101) Work order will be evaluated against site circumstances	Ensure occupant safety Determine and ensure appropriate device and location		4926
7.8003.2b Selection	Exit signs will meet all applicable codes (UL 924, NFPA 70, and/or IBC and IFC, as appropriate) and shall be selected from the NEMA Premium Exit Sign List Existing battery backup signs will be replaced with new battery backup signs in accordance with NEC 70 Section 700.12(F) Exit signs will be capable of being attached to existing outlet box Battery backup exit signs will indicate system failure with visual and audible alarm Exit signs will be rated for a maximum of 5 watts per illuminated side Exit signs will carry at least a 1-year warranty	Ensure occupant safety Ensure low energy use Provide quality exit sign		4927
7.8003.2c Installation	Fixture will be de-energized before beginning work Appropriate lockout procedures will be followed in accordance with OSHA 1910 Subpart S and ANSI/NFPA 70E Exit signs will be installed in accordance with all applicable codes (NFPA 70) and manufacturer specifications All penetrations will be sealed per ANSI/NFPA/ICC Building Code or applicable local code Any penetrations created will be patched and painted	Ensure proper equipment operation Protect integrity of building envelope and exit sign Ensure worker safety Ensure integrity of fire barrier		4928

7.8003.2d Commissioning	Battery backup exit signs will be tested to meet NEC 70 Section 700.12(F) Battery backup exit signs will be tested to simulate loss of power Exit signs will be tested in accordance with local ordinances and manufacturer specifications Exit sign placement will be in accordance with ANSI/NFPA 101	Ensure sign visibility and correct operation Ensure occupant safety		4929
7.8003.2e Decommissioning	Exit signs will be disposed of in accordance with EPA guidelines, local ordinances, or manufacturer specifications	Protect the environment Prevent the reuse of inefficient components		4930
7.8003.2f Safety	Broken lamps containing mercury will be cleaned up in accordance with EPA guidelines	Ensure worker safety Ensure occupant safety		4931

7.8003.3 Emergency Lighting

Topic: Plug Load

Subtopic: Lighting

Desired Outcome: Energy used for lighting reduced

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8003.3a Assessment	Lighting strategy will be provided by lighting professional Work order will be evaluated against site circumstances	Determine and ensure appropriate device and location		4932
7.8003.3b Selection	Emergency light fixtures will meet the appropriate nationally recognized product standard (UL 542, UL 1570) Emergency lighting will include battery backup capable of operating for 90 minutes and will comply with NFPA 70 section 700.12 Outdoor lamps will be suitable for local climate conditions and in accordance with ANSI/UL product standards Linear fluorescent lamps will not be replaced with T12 lamps, and T8 lamps will be installed as minimum standard	Reduce energy use Ensure device functions properly Ensure product safety Ensure occupant satisfaction Ensure adequate lighting during emergency situations		4933

	Lamps in luminaires with emergency ballasts shall be replaced with a appropriate type of lamp Vandal-proof fixtures will be used, if appropriate			
7.8003.3c Installation	Fixture will be de-energized before work begins Worker will follow appropriate lockout procedures in accordance with OSHA 1910 Subpart S and ANSI/NFPA 70E Lamps will be installed in accordance with manufacturer specifications If fixture is broken, worker will refer to SWS 7.8003.14 Fixture Replacement Lens and reflector will be cleaned	Ensure worker safety Ensure occupant safety Ensure continued savings Optimize fixture performance		4934
7.8003.3d Commissioning	Emergency lighting will not inhibit required egress lighting, as required by ANSI/NFPA 101 Battery backup will be tested to meet NEC 70 Section 700.12(F) Battery backup emergency lighting will be tested to simulate loss of power Emergency lighting will be tested in accordance with local ordinances and manufacturer specifications Exit sign placement will be in accordance with NFPA 110	Meet target light levels Ensure occupant satisfaction Ensure occupant safety		4935
7.8003.3e Decommissioning	Lamps will be disposed of in accordance with EPA guidelines, local ordinances, or manufacturer specifications	Protect the environment Prevent the reuse of inefficient components		4936
7.8003.3f Safety	Broken lamps containing mercury will be cleaned in accordance with EPA guidelines	Ensure worker safety Ensure occupant safety		4937
7.8003.3g Staff education	Building operations staff will be provided with warranty information, product specification, and installer contact information	Educate building operations staff about operation and maintenance of equipment		4938
7.8003.3h Occupant education	Education regarding emergency lighting will be provided by building operations staff	Ensure occupant safety		4939

7.8003.4 Remove Common Area Lamps

Topic: Plug Load

Subtopic: Lighting

Desired Outcome: Electrical use and demand reduced

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8003.4a Assessment	Delamping strategy will be provided by lighting professional and follow IESNA protocol for appropriate light levels for certain tasks	Determine relevant lamp removal Determine appropriate strategy		4940
7.8003.4b Removal	Lamps will be removed based on the strategy provided by assessment	Reduce energy use and demand		4941
7.8003.4c Safety	Final lighting levels will be in accordance with ASHRAE 90.1 or 90.2 Final egress lighting will be in accordance with NFPA 70 and NFPA 101	Ensure that occupant egress lighting safety has not been compromised		4942
7.8003.4d Decommissioning	If operational, lamps will be stored and reused if the lamps meet retrofit standards If nonoperational, lamps will be disposed of in accordance with local ordinances or manufacturer specifications Disposal manifests will be filed and available to building representatives	Use resources efficiently Reduce cost of lamp replacement Protect the environment		4943
7.8003.4e Occupant safety	Delamping will not impact required egress lighting, as required by ANSI/NFPA 101	Ensure occupant safety		4944
7.8003.4f Staff education	Building operations staff will be provided with warranty information, operation manuals, and installer contact information	Educate building operations staff about operation and maintenance of equipment Ensure continued savings		4945
7.8003.4g Occupant education	Occupants will be educated of new lighting levels and benefits Education will be provided by building operations staff	Educate occupants about new lighting levels and benefits Ensure continued savings		4946

7.8003.5 Remove Common Area Fixtures

Topic: Plug Load

Subtopic: Lighting

Desired Outcome: Electrical use and demand reduced

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

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8003.5a Assessment	Delamping strategy will be provided by lighting professional in consultation with licensed electrician Remaining fixtures will follow IESNA protocol for appropriate light levels for certain tasks	Determine relevant fixture removal Determine appropriate strategy		4947
7.8003.5b Decommissioning	Fixtures will be removed or disconnected by a licensed electrician or qualified contractor based on the strategy provided by assessment Removal or disconnection will be in accordance with ANSI/NFPA 70 and ANSI/NFPA 70E Any penetrations caused by fixture removal will be patched, sealed, and painted with equivalent material (ANSI/NFPA/ICC Fire Code) If operational, lamps will be stored and reused if the lamps meet retrofit standards Fixtures, lamps, and ballasts will be disposed of in accordance with local ordinances or manufacturer specifications Disposal manifests will be filed and available to building representatives	Reduce energy use and demand Ensure occupant safety Ensure worker safety Preserve integrity of building envelope Ensure integrity of fire barrier Use resources efficiently Reduce operational budget costs Protect the environment		4948
7.8003.5c Safety	Final lighting levels will be in accordance with ASHRAE 90.1 or 90.2 Final egress lighting will be in accordance with ANSI/NFPA 70 and ANSI/NFPA 101 or in compliance with local codes	Ensure occupant egress lighting safety has not been compromised		4949
7.8003.5d Occupant safety	Delamping will not impact required egress lighting, as required by ANSI/NFPA 101	Ensure occupant safety		4950
7.8003.5e Staff education	Building operations staff will be provided with warranty	Educate building operations staff about operation and maintenance of equipment		4951

	information, operation manuals, and installer contact information	Ensure continued savings		
7.8003.5f Occupant education	Occupants will be educated of new lighting levels and benefits Education will be provided by building operations staff	Educate occupants about new lighting levels and benefits Ensure continued savings		4952

7.8003.6 Occupancy Sensors for Indoor Common Areas and Offices

Topic: Plug Load

Subtopic: Lighting

Desired Outcome: Energy used for lighting reduced

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

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8003.6a Assessment	Lighting strategy will be provided by lighting professional	Determine appropriate device, settings, and location Determine existing electrical conditions		4953
7.8003.6b Selection	Sensors will be compatible with existing wiring Sensors will meet UL 60730-1	Ensure device functions appropriately Ensure product safety		4954
7.8003.6c Installation	Work will be performed by licensed electrical professional Sensor will be installed in accordance with ANSI/NFPA 70, ANSI/NFPA 70E, and manufacturer specifications All penetrations will be sealed (ANSI/NFPA/ICC Fire Code)	Ensure worker safety Ensure occupant safety Preserve integrity of building envelope Ensure integrity of fire barrier		4955
7.8003.6d Settings	Settings will match the intended use of the space in accordance with lighting plan	Reduce energy use		4956
7.8003.6e Commissioning	Settings will be verified and tested to meet lighting design criteria For certain tasks, lighting levels will follow IESNA protocol for appropriate light levels	Optimize system performance Ensure occupant safety		4957
7.8003.6f Occupant safety	Occupancy sensors will not inhibit required egress lighting, as required by ANSI/NFPA 101 Occupancy sensors will not be installed in electrical and mechanical rooms	Ensure occupant safety Ensure worker safety		4958

7.8003.6g Staff education	Building operations staff will be provided with warranty information, operation manuals, and installer contact information	Educate building operations staff about operation and maintenance of equipment Ensure continued savings		4959
7.8003.6h Occupant education	Occupants will be educated of new lighting controls and benefits Education will be provided by building operations staff	Educate occupants about new controls and benefits Ensure continued savings		4960

7.8003.7 Stand-Alone Timers in Outdoor and Common Areas

Topic: Plug Load

Subtopic: Lighting

Desired Outcome: Energy used for lighting reduced

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

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8003.7a Assessment	Lighting strategy will be provided by lighting professional Safety and crime prevention will be considered as part of the strategy	Determine appropriate device, settings, and location Determine existing electrical conditions Prevent property damage Ensure occupant safety		4961
7.8003.7b Selection	Timer will be compatible with existing wiring Timer will be in accordance with UL 917 where applicable Timer will have a minimum of 10 hours of battery backup time Timer will have a minimum of two programmable schedules	Reduce energy use Ensure device functions appropriately Ensure product safety		4962
7.8003.7c Installation	Work will be performed by licensed electrical professional Timer will be installed in accordance with ANSI/NFPA 70, ANSI/NFPA 70E, and manufacturer specifications Timer will be positioned in a secure location	Ensure worker safety Ensure occupant safety Ensure continued savings Prevent tampering		4963
7.8003.7d Settings	Timer will be set in accordance with the assessment Exterior fixtures will be turned off when there is sufficient day light (civil twilight) or when lighting is no longer needed at night per	Reduce energy use Reduce light pollution Prevent property damage Ensure occupant safety		4964

	ASHRAE 90.1 or 90.2, and tested to meet IESNA protocol for appropriate light levels for certain tasks Interior fixtures will be turned off when light is no longer needed			
7.8003.7e Commissioning	Settings will be verified and tested to meet lighting design criteria	Optimize system performance Ensure occupant safety		4965
7.8003.7f Occupant safety	Timer will not impact egress lighting, as required by ANSI/NFPA 101 Timer will not impact minimum light level, as required by codes or local ordinances Fixtures will be on when spaces are occupied, per ASHRAE 90.1 or 90.2 or local codes, and tested to meet IESNA protocol for appropriate light levels for certain applications Appropriate override switch shall be provided	Ensure occupant safety		4966
7.8003.7g Staff education	Building operations staff will be provided with warranty information, operation manuals, and installer contact information	Educate building operations staff about operation and maintenance of equipment Ensure continued savings		4967
7.8003.7h Occupant education	Occupants will be educated of new lighting controls and benefits Education will be provided by building operations staff	Educate occupants about new controls and benefits Ensure continued savings		4968

7.8003.8 Outdoor Motion Control

Topic: Plug Load

Subtopic: Lighting

Desired Outcome: Energy used for lighting reduced

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

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8003.8a Assessment	Lighting strategy will be provided by lighting professional Safety and crime prevention will be considered as part of the strategy	Determine appropriate device, settings, and location Determine existing electrical conditions Prevent property damage Ensure occupant safety		4969

7.8003.8b Selection	Motion sensor will be compatible with existing wiring Motion sensor will meet UL 60730-1	Reduce energy use Ensure device functions appropriately Ensure product safety		4970
7.8003.8c Installation	Work will be performed by licensed electrical professional Motion sensor will be installed in accordance with ANSI/NFPA 70, ANSI/NFPA 70E, and manufacturer specifications Motion sensor will be located in a secure location and not subject to physical damage Motion sensor will be installed to minimize false starts	Ensure worker safety Ensure occupant safety Prevent tampering Ensure continued savings		4971
7.8003.8d Settings	Motion sensor will be set in accordance with the assessment	Reduce energy use Reduce light pollution Prevent property damage Ensure occupant safety		4972
7.8003.8e Commissioning	Settings will be verified and tested to meet lighting design criteria	Optimize system performance Ensure occupant safety		4973
7.8003.8f Occupant safety	Motion sensor will not impact egress lighting, as required by ANSI/NFPA 101 Motion sensor will not impact minimum light level, as required by codes or local ordinances	Ensure occupant safety		4974
7.8003.8g Staff education	Building operations staff will be provided with warranty information, operation manuals, and installer contact information	Educate building operations staff about operation and maintenance of equipment Ensure continued savings		4975
7.8003.8h Occupant education	Occupants will be educated of new lighting controls and benefits Education will be provided by building operations staff	Educate occupants about new controls and benefits Ensure continued savings		4976

7.8003.9 Outdoor Photo Sensors

Topic: Plug Load

Subtopic: Lighting

Desired Outcome: Energy used for lighting reduced

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

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)	

7.8003.9a Assessment	Lighting strategy will be provided by lighting professional Safety and crime prevention will be considered as part of the strategy	Determine appropriate device, settings, and location Determine existing electrical conditions Prevent property damage Ensure occupant safety		4977
7.8003.9b Selection	Photo sensor will be compatible with existing wiring Photo sensor will be UL certified Photo sensor will meet the requirements of the lighting design Fixture will allow for replacement of photo sensor	Reduce energy use Ensure device functions appropriately Ensure product safety Ensure continued savings		4978
7.8003.9c Installation	Work will be performed by licensed electrical professional Photo sensor will be installed in accordance with ANSI/NFPA 70, ANSI/NFPA 70E, and manufacturer specifications Photo sensor will be positioned in a secure location and not subject to physical damage Photo sensor will not be obstructed from natural light	Ensure worker safety Ensure occupant safety Ensure continued savings Prevent tampering		4979
7.8003.9d Settings	Photo sensor and aperture will be set in accordance with the assessment	Ensure sensor performance		4980
7.8003.9e Commissioning	Settings will be verified and tested to meet lighting design criteria	Optimize system performance Reduce light pollution		4981
7.8003.9f Occupant safety	Photo sensor will not impact required egress lighting, as required by ANSI/NFPA 101 Photo sensor will not impact required minimum light level, as required by codes or local ordinances	Ensure occupant safety		4982
7.8003.9g Staff education	Building operations staff will be provided with warranty information, operation manuals, and installer contact information	Educate building operations staff about operation and maintenance of equipment Ensure continued savings		4983

7.8004.3 Clothes Dryer Replacement

Topic: Plug Load

Subtopic: Laundry

Desired Outcome: Reduce energy and environmental impact for drying clothes

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8004.3a Assessment	Unit and electrical receptacle will meet requirements of NFPA 70 Article 422	Determine and ensure appropriate device and location		5026
7.8004.3b 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 1 watt or less Appliance will be covered by a minimum 1-year warranty	Reduce energy use Avoid increasing total energy use (gas and electric) when fuel switching Ensure product safety Ensure occupant satisfaction		5027
7.8004.3c Installation	Appliance will be installed according to 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 outdoors using rigid metal-to-metal venting • Venting design will meet standards for optimal venting, including demand control venting • Venting will not be constricted or blocked • Only clamps, not screws, will be used on vents • Pest screen will be installed at the termination • At least 3' of the vent closest to the exterior of the house will be insulated Where applicable, appliance shall be accessible to the disabled, as required by the Federal Fair Housing Act and ICC A117.1; the appliance shall not reduce required maneuvering clearances in the	Ensure worker safety Ensure occupant safety Ensure continued savings Achieve intended appliance function		5028

	kitchen to less than that permitted by the AHJ If a combustion appliance is used, the building must pass a combustion appliance zone test upon completion of installation Any penetrations to the exterior created by the installation of the appliance will be sealed			
7.8004.3d Commissioning	Confirm appliance is operating in accordance with manufacturer specifications indicated in operation and maintenance manuals	Ensure occupant satisfaction Ensure occupant safety		5029
7.8004.3e Decommissioning	Appliances replaced by new units will be recycled or disposed of properly Appliances infested with pests will be enclosed before moving	Protect the environment Prevent the reuse of inefficient components		5030
7.8004.3f Safety	All OSHA standard practices will be followed	Ensure worker safety Ensure occupant safety		5031
7.8004.3g Staff education	Warranty information, operation manuals, and installer contact information will be provided to the building operations staff All equipment controls will be demonstrated to the building operations staff	Educate building operations staff about operation and maintenance of equipment Ensure continued savings		5032
7.8004.3h Occupant education	Specific information on the proper maintenance of the equipment will be provided to the occupants All equipment controls and proper operation will be demonstrated to the occupants Operators of clothes dryers will be provided with information on using the clothes dryers safely and effectively; this will include information on items that are prohibited to be placed in the clothes dryer (Refer to the Association of Home Appliance Manufacturers recommendations)	Educate occupants about appliance and benefits Ensure continued savings		5033

7.8005.1 Refrigerated Beverage Vending Machines

Topic: Plug Load

Subtopic: Vending Machines and Water Coolers

Desired Outcome: Energy used for vending machines reduced

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)	
7.8005.1a Selection	Vending machines, including those leased from a third-party vendor, will be ENERGY STAR® qualified and compliant with ANSI/UL 541	Increase energy efficiency Ensure occupant safety	5034
7.8005.1b Installation	Cord and plug-connected vending machines will comply with ANSI/NFPA 70 Section 422.51 Where applicable per ADA, clear floor space and unit controls complying with the operable parts provisions of ICC A117.1 shall be provided for each type of vending machine provided Motion controls will be installed for all non-refrigeration functions Building operations staff will be provided warranty information, operation manuals, and installer contact information Vandal-proof enclosures will be installed, as necessary	Ensure occupant safety Reduce light pollution Minimize nonessential energy use	5035
7.8005.1c Decommissioning	Vending machines replaced by new units will be recycled or disposed of in accordance with local ordinances Vending machines infested with pests will be enclosed before moving All refrigerant will be handled in accordance with EPA 40 CFR 82.156 and local ordinances	Prevent reuse of inefficient equipment and components Protect the environment Ensure worker safety	5036
7.8005.1d Staff education	Building operations staff will be provided with warranty information, operation manuals, and installer contact information	Educate building operations staff about operation and maintenance of equipment Ensure continued savings	5037
7.8005.1e Occupant education	Occupants will be educated of new lighting controls and benefits Education will be provided by building operations staff	Educate occupants about new controls and benefits Ensure continued savings	5038

7.8005.2 Non-Refrigerated Vending Machines

Topic: Plug Load

Subtopic: Vending Machines and Water Coolers

Desired Outcome: Energy used for vending machines reduced

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8005.2a Selection	All vending machines will be compliant with ANSI/UL 751	Ensure occupant safety		5039
7.8005.2b Installation	Cord and plug-connected vending machines will comply with ANSI/NFPA 70 Section 422.51 Where applicable per ADA, clear floor space and unit controls complying with the operable parts provisions of ICC A117.1 shall be provided for each type of vending machine provided Motion controls will be installed Warranty information, operation manuals, and installer contact information will be provided to building operations staff Vandal-proof enclosures will be installed, as necessary	Ensure occupant safety Reduce light pollution Minimize nonessential energy use		5040
7.8005.2c Decommissioning	Vending machines replaced by new units will be recycled or disposed of in accordance with local ordinances Vending machines infested with pests will be enclosed before moving	Prevent reuse of inefficient equipment and components Protect the environment Ensure worker safety		5041
7.8005.2d Occupant safety	Appliance will not impact required egress, as required by ANSI/NFPA 101	Ensure occupant safety		5042
7.8005.2e Staff education	Building operations staff will be provided with warranty information, operation manuals, and installer contact information	Educate building operations staff about operation and maintenance of equipment Ensure continued savings		5043
7.8005.2f Occupant education	Occupants will be educated of new lighting controls and benefits Education will be provided by building operation staff	Educate occupants about new controls and benefits Ensure continued savings		5044

7.8005.3 Freestanding Water Coolers

Topic: Plug Load

Subtopic: Vending Machines and Water Coolers

Desired Outcome: Energy used for freestanding bottled and point-of-use water coolers reduced

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8005.3a Selection	Freestanding water coolers, including those leased from a third-party vendor, will be ENERGY STAR® qualified Child-resistant hot faucet will be included for hot water delivery	Increase energy efficiency Ensure occupant safety		5045
7.8005.3b Installation	Freestanding water coolers will be installed in accordance with manufacturer specifications If applicable, equipment shall have outlets provided that comply with the operable parts provisions of the ICC A117.1	Ensure proper appliance operation		5046
7.8005.3c Decommissioning	Freestanding water coolers replaced by new units will be recycled or disposed of in accordance with local ordinances Refrigerant will be handled in accordance with Section 608 of Clean Air Act of 1990 and local ordinances	Prevent reuse of inefficient equipment and components Protect the environment		5047
7.8005.3d Staff education	Building operations staff will be provided with warranty information, operation manuals, and installer contact information	Educate building operations staff about operation and maintenance of equipment Ensure continued savings		5048

7.8101.2 Low-Flow Retrofit Devices

Topic: Water Heating

Subtopic: Water Use Reduction

Desired Outcome: Safe and reliable hot water delivery system that meets the needs of the occupant/building management/building operations staff at the lowest possible life-cycle cost

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8101.2a Removal	Work area will be dry Care will be taken not to damage existing plumbing fixtures, finishes, and surroundings Unusual pressure conditions will be noted and communicated to property manager (e.g., high, low, fluctuating) Existing showerhead or aerator will be removed	Ensure work area is safe Prevent water damage to living unit		5049
7.8101.2b Installation	Low-flow showerheads or aerators will be installed using a non-hardening thread sealant	Ensure safe and quality installation Eliminate crossover		5050

	Temperature-protected shutoff valves will be used Showerheads with shut off valves will not be installed in buildings with central water heating systems			
7.8101.2c Commissioning	Proper function at the fixture will be verified by turning water on to full flow Notification should be given to tenants informing them not to remove low flow showerheads to maintain energy efficiency	Verify the new end-use device is operating properly		5051

7.8101.4 Washing Machine

Topic: Water Heating

Subtopic: Water Use Reduction

Desired Outcome: Energy and environmental impact for washing clothes reduced

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8101.4a Assessment	Unit and electrical receptacle will meet requirements of NFPA 70	Determine and ensure appropriate device and location		5052
7.8101.4b Selection	Minimum appliance efficiency will be ENERGY STAR® and WaterSense® or better Washers within ENERGY STAR standards or CEE Tier 2 will be considered to achieve greater savings Adequate clearance will be maintained around appliance when fit in available space so access to cabinets and light switches are not blocked Appliance will be covered by a minimum 1-year warranty Equipment will be selected with features that reduce both peak electric demand and absolute energy use and water use	Reduce energy use and water consumption Ensure occupant satisfaction with appliance		5053
7.8101.4c Installation	Appliance will be installed according to manufacturer specifications (e.g., leveling, plumbing connection, electrical connection, interior lighting) and meet all applicable codes	Ensure worker safety Ensure occupant safety Ensure equipment functions as designed Reduce water consumption Prevent water damage		5054

	Outlet will be grounded or provide ground Shut off valves will be installed, if not already present Water and electricity to existing washer will be shut off and disconnected Function and proper connection (hot to hot/cold to cold) of hot and cold supply to washer will be verified Hot water temperature shall be confirmed to be a maximum of 125°F or according to local code Washer will operate through all cycles Washer will be labeled with contact information Information listing poison control contacts shall be provided Floor surfaces and surroundings will be protected when removing washing machine Hoses that can withstand water pressure at the location will be installed If appliance is located in conditioned or finished area, overflow pan will be installed and drained to appropriate location Any penetrations to the exterior created by the installation of the appliance will be sealed Central laundry facilities will be considered over in-unit laundry rooms Water quality will be evaluated via pH tests if area is prone to hard water conditions Warranty information, operation manuals, and installer contact information will be provided to the occupant	Educate occupants on how to maintain washer to ensure savings		
7.8101.4d Commissioning	Confirm appliance is operating in accordance with manufacturer specifications indicated in operation and maintenance manuals	Ensure occupant satisfaction Ensure occupant safety		5055
7.8101.4e Decommissioning	Appliances replaced by new units will be recycled or disposed of properly	Prevent the reuse of inefficient equipment and its components Reduce waste		5056

	Appliances infested with pests will be enclosed before moving	Ensure occupant health		
7.8101.4f Safety	All OSHA-standard practices will be followed	Ensure worker safety Ensure occupant safety		5057
7.8101.4g Staff education	Warranty information, operation manuals, and installer contact information will be provided to the building operations staff Energy-related appliance controls will be demonstrated to the occupant	Educate building operations staff about operation and maintenance of equipment Ensure continued savings		5058
7.8101.4h Occupant education	Specific information on the proper maintenance of the equipment will be provided to the occupants All equipment controls will be demonstrated to the occupants	Educate occupants about appliance and benefits Ensure continued savings		5059

7.8101.5 In-Unit Dishwasher Replacement

Topic: Water Heating

Subtopic: Water Use Reduction

Desired Outcome: Energy used for dishwashing reduced

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 Building America Solution Center.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8101.5a Assessment	Assessment will determine if dishwasher connection is cord and plug or directly connected; if directly connected, a means to disconnect the appliance should be provided in accordance with NEC 422.31 Appliance electrical connection shall determine if NEC 422.16 or NEC 422.31 applies Work order will be evaluated against site circumstances	Determine appropriate appliance		5060
7.8101.5b Selection	Appliance will be ENERGY STAR® qualified or better Appliance will fit in the available space without blocking access to light switches, cabinets, etc. Appliance will carry a minimum 1-year warranty	Reduce energy use Ensure occupant satisfaction		5061

7.8101.5c Installation	Directly connected dishwasher will be installed by licensed electrical professional Directly connected appliance will be de-energized before beginning work For directly connected appliance, appropriate lockout procedures will be followed in accordance with OSHA 1910 Subpart S and ANSI/NFPA 70E Directly connected dishwasher will comply with ANSI/NFPA 70 Cord and plug connected dishwasher will comply with ANSI/NFPA 70 Section 422.16 Plumbing connections will be sealed to prevent leaks Plumbing supply lines will be installed with the shortest length possible Appliance will be installed in accordance with manufacturer specifications Water quality will be evaluated via pH and hardness tests The occupant will be informed on detergent levels and type to optimize performance	Ensure worker safety Ensure occupant safety Ensure proper appliance performance Limit water use of appliance		5062
7.8101.5d Commissioning	Dishwasher will be run for one full cycle Worker will inspect for water leaks during operation Hot water temperature will be confirmed to be a maximum of 125 °F or according to local code	Ensure proper appliance performance Prevent property damage		5063
7.8101.5e Decommissioning	Dishwasher will be recycled or disposed of in accordance with local ordinances Dishwashers infested with pests will be enclosed before moving	Protect the environment Prevent the reuse of inefficient components Ensure worker safety		5064
7.8101.5f Staff education	Building operations staff will be provided with warranty information, operation manuals, water shut off valve location, and installer contact information	Educate building operations staff about operation and maintenance of equipment Ensure continued savings		5065
7.8101.5g Occupant education	Occupants will be provided with a manual and educated of new dishwasher benefits	Educate occupants about new controls and benefits Ensure continued savings		5066

	Education will be provided by building operations staff Dishwasher detergent levels shall be determined per owner's manual			

7.8101.6 Drain Heat Recovery

Topic: Water Heating

Subtopic: Water Use Reduction

Desired Outcome: Reduce hot water use at the primary fixtures through heat recovery from the drain

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8101.6a Hazardous material removal	Health concerns in the removal and replacement of equipment (e.g., asbestos) will be identified Upon the discovery of hazardous material, written notification and contact information for regional EPA asbestos coordinator will be provided to appropriate people (e.g., occupant, building operations staff, property manager) Property manager will be asked to contract with an EPA-certified asbestos contractor to conduct abatement before decommissioning and replacement (property manager is responsible for abatement or remediation)	Remediate health hazards using EPA-certified contractors		5067
7.8101.6b Location	Drain heat recovery will be installed where: • Cold water draw is concurrent with a warm drain • Vertical drop of drain is sufficient to allow installation of the recovery device	Identify locations that allow for cost-effective heat recovery		5068
7.8101.6c Installation	Drain heat recovery device will be installed in accordance with manufacturer specifications (e.g., cold water counter flow)	Maximize effectiveness of heat exchange		5069
7.8101.6d Cold/tempered water supply	The tempered water line (post-drain heat recovery device) will be plumbed: • As close to the primary fixture as possible (e.g., showerhead)	Minimize heat loss from tempered water		5070

	• To fixtures that will have water use concurrent with drain heat recovery (e.g., shower that is supplying the drain water)			
7.8101.6e Commissioning	Drain heat recovery device will be checked for leaks Cold water line above drain heat recovery device will be checked for warmth	Ensure system operates as designed		5071

7.8102.4 Storage Tank-Type Water Heater

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

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8102.4a 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 before decommissioning and replacement (occupant is responsible for abatement or remediation)	Remediate health hazards using EPA-certified contractors		5072
7.8102.4b Decommissioning	Accepted industry procedures and practices will be followed to: • Remove old water heater and associated components • Seal any unused chimney openings • Remove unused oil tank, lines, valves, and associated equipment	Ensure worker and occupant safety Preserve integrity of the building Remove old equipment in a timely and efficient manner		5073

7.8102.4c New equipment installation	New water heater and associated components will be installed in accordance with local codes, accepted industry standards and practices, 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 Where earthquake loads are applicable, supports shall be designed and installed for seismic forces In instances where conflicts occur between the code and the manufacturer's installation instructions, the more restrictive provisions shall apply	Ensure worker and occupant safety Preserve integrity of the building Remove old equipment in a timely and efficient manner		5074
7.8102.4d Emergency drain pan	An emergency drain pan with a minimum depth of 1 1/2" and sufficient size and shape to receive all dripping or condensate if leakage would cause damage to the space should be installed. A 3/4" drain line or larger will be connected to tapping on pan and run to an indirect drain or pumped to daylight	Collect and safely dispose of water escaping from the storage tank		5075
7.8102.4e Expansion tank	A stainless steel bladder expansion tank will be installed on the cold water side Expansion tank shall be installed in accordance with the manufacturer's installation instructions A direct connection with no valves between the storage tank and expansion tank will be installed	Protect the storage tank from expansion		5076
7.8102.4f Temperature and pressure relief valve	Correct temperature and pressure relief valve will be installed in accordance with manufacturer specifications Temperature and pressure relief valve discharge tube will terminate within 6" of the floor, or as prescribed by local code	Discharge excessive energy (pressure or temperature) from storage tank to safe location		5077

7.8102.4g Dielectric unions (dielectric insulator)	Dielectric unions (dielectric insulator) will be installed in accordance with manufacturer specifications	Break the stray voltage electrical circuit through the storage tank		5078
7.8102.4h Backflow prevention	Backflow prevention will be installed in accordance with manufacturer specifications and all applicable codes Backflow devices shall be tested by a certified backflow assembly tester at the time of installation, repair, or relocation.	Protect water supply from contamination		5079
7.8102.4i Thermal efficiency and insulation	If additional tank insulation is installed, it will be rated a minimum of R-11 and 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 Pipe insulation must remain 3" from gas water heater vent Heat traps will be installed on the inlet and outlet piping where not provided by manufacturer	Reduce standby loss from near tank piping and storage tank Ensure insulation does not make contact with flue gas venting		5080
7.8102.4j Required combustion air	Combustion air shall be calculated and provided in conformance with the applicable code adopted by the jurisdiction and manufacturer's installation requirements In instances where conflicts occur between the code and the manufacturer's installation instructions, the more restrictive provisions shall apply In absence of a local code, combustion air shall be calculated and provided in conformance with any of the following: NFPA 54, IFGC, or NFPA 31	Ensure adequate combustion air for operation of the appliance		5081
7.8102.4k Venting of flue gases	Combustion byproducts shall be removed in accordance with the applicable code adopted by the	Ensure the safety and durability of the venting system		5082

	jurisdiction and manufacturer's installation requirements In instances where conflicts occur between the code and the manufacturer's installation instructions, the more restrictive provisions shall apply In absence of a local code, combustion byproducts shall be removed in accordance with any of the following: NFPA 54, IFGC, or NFPA 31			
7.8102.4l Combustion testing	Undiluted flue gases will be checked with a calibrated flue gas analyzer in accordance with accepted protocol If combustion is not happening safely or to the appropriate combustion efficiency, diagnostics and adjustments will be done in accordance with manufacturer specifications and local codes	Confirm that combustion is occurring safely with appropriate combustion efficiency		5083
7.8102.4m Fuel supply	Electric, natural gas, and oil supply components will be installed to accepted industry standards and codes in accordance with NFPA70 (NEC) for electric, NFPA 54 for gas, or NFPA 31 for oil Energy input required by the appliance will be in accordance with manufacturer specifications (e.g., ensure gas pipe size and pressure are adequate)	Provide sufficient fuel to the water heater, burner, or element		5084
7.8102.4n Discharge water temperature	Discharge water temperature at fixtures will not exceed 120 °F or as prescribed by local code Install mixing valve when higher storage/generation temperatures are required	Ensure safe hot water supply temperature to fixtures		5085
7.8102.4o 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	Ensure system functions safely Keep cost of ownership as low as possible		5086

	Commissioning will be in accordance with manufacturer specifications and relevant industry standards			
7.8102.4p Occupant health and safety	All spaces with combustion appliances will have a carbon monoxide (CO) alarm Locations of CO alarms in the space shall be in accordance with state law and local codes Ambient CO levels will be maintained under code-acceptable thresholds	Ensure occupant health and safety		5087
7.8102.4q Occupant education	Completed work will be reviewed Completed work will be reviewed Occupant/building operations staff/property manager will be educated on the safe and efficient operation and maintenance of the system, including: • Adjustment of water temperature • Operation of backflow preventer and pressure regulator • Importance of keeping operating manuals accessible	Educate occupant/building operations staff/property manager about the safe, efficient operation and maintenance of the system		5088

7.8102.5 Tankless Water Heater

Topic: Water Heating

Subtopic: Installation and Replacement

Desired Outcome: Provide a safe and reliable hot water source that meets the needs of the occupant/building management/building operations staff at the lowest possible life cycle cost

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8102.5a Hazardous material removal	Health concerns in the removal and replacement of equipment (e.g., asbestos, other hazardous materials) will be identified Upon the discovery of hazardous material, written notification and contact information for regional EPA asbestos coordinator will be provided to appropriate people	Remediate health hazards using EPA-certified contractors		5089

	(e.g., occupant/building operations staff) Property manager will be asked to contract with an EPA-certified asbestos contractor to conduct abatement before decommissioning and replacement (property manager is responsible for abatement or remediation)			
7.8102.5b Decommissioning	Decommission the applicable system components by completing the following, in accordance with accepted industry procedures and practices: • Remove old water heater and associated components • Seal any unused chimney openings • Safely disconnect and secure any abandoned utility (fuel and electric) connections	Preserve the integrity of the building and services Remove old equipment in a timely and efficient manner		5090
7.8102.5c New equipment installation	Tankless water heaters and associated components will be installed in accordance with local codes, accepted industry standards and practices, and manufacturer specifications In instances where conflicts occur between the code and the manufacturer's installation instructions, the more restrictive provisions shall apply	Ensure the health and safety of the worker/occupant/building management/building operations staff		5091
7.8102.5d Emergency drain pan	In instances where, due to the installation location of the tankless water heater, a leak could cause damage building components, an emergency drain pan should be installed A 3/4" drain line or larger will be connected to tapping on pan and run emergency drain line to floor drain, pump, or building exterior	Collect and safely dispose of water escaping from the appliance		5092
7.8102.5e Temperature and pressure relief valve	Correct temperature and pressure relief valve will be installed in accordance with manufacturer specifications	Discharge excessive energy (pressure or temperature) from the appliance to a safe location		5093

	Equipment will be connected to properly sized discharge tube and run to a safe location no greater than 6" from the floor or as prescribed by local code (in the absence of local code, as prescribed by UPC)			
7.8102.5f Dielectric unions (dielectric insulator)	Dielectric unions (dielectric insulator), if needed, will be installed in accordance with manufacturer specifications	Minimize corrosion between dissimilar metals		5094
7.8102.5g Stray voltage protection	Electrical connection to the water heating equipment should be made per manufacturer's instructions and per NEC (NFPA 70)	Break the stray voltage electrical circuit through the appliance		5095
7.8102.5h Backflow prevention	Backflow prevention will be installed in accordance with manufacturer specifications and all applicable codes Backflow devices shall be tested by a certified backflow assembly tester at the time of installation, repair, or relocation, and not less than on an annual schedule or more often where required by local code	Protect the water supply from contamination		5096
7.8102.5i Pressure verification	Building water pressure and volume will be verified as sufficient and will be in accordance with manufacturer specifications A pressure regulator or booster pump will be installed as needed	Provide proper water pressure to the appliance		5097
7.8102.5j Pipe insulation	All piping and fittings will be insulated with fixed insulation to IECC or ASHRAE 90.1, at a minimum	Reduce line losses		5098
7.8102.5k Required combustion air	Recommendations will be made to install all tankless appliances as sealed combustion If not possible: Combustion air shall be calculated and provided in conformance with the applicable code adopted by the jurisdiction and manufacturer's installation requirements In instances where conflicts occur between the code and the manufacturer's installation	Ensure adequate combustion air for operation of the appliance		5099

	instructions, the more restrictive provisions shall apply In absence of a local code, combustion air shall be calculated and provided in conformance with any of the following: NFPA 54, IFGC, or NFPA 31			
7.8102.5l Venting of flue gases	Combustion byproducts shall be removed in accordance with the applicable code adopted by the jurisdiction and manufacturer's installation requirements In instances where conflicts occur between the code and the manufacturer's installation instructions, the more restrictive provisions shall apply In absence of a local code, combustion byproducts shall be removed in accordance with any of the following: NFPA 54, IFGC, or NFPA 31	Ensure the safety and durability of the venting system		5100
7.8102.5m Combustion testing	Undiluted flue gases will be checked with a calibrated flue gas analyzer in accordance with accepted protocol If combustion is not happening safely or to maximum efficiency, diagnostics and adjustments will be done in accordance with manufacturer specifications and local codes	Confirm that combustion is occurring safely with maximum efficiency		5101
7.8102.5n Fuel supply	Electric, natural gas, and oil supply components will be installed to accepted industry standards and codes in accordance with NFPA 70 (NEC) for electric, NFPA 54 for gas, or NFPA 31 for oil Energy input required by the appliance will be in accordance with manufacturer specifications (e.g., ensure gas pipe size and pressure are adequate)	Provide sufficient fuel to the water heater burner or element		5102
7.8102.5o Discharge water temperature	Discharge water temperature will be set not to exceed 120 °F or as prescribed by local code Install mixing valve when higher storage/generation temperatures are required	Ensure water temperature is low enough to prevent scalding Ensure water temperature is high enough to inhibit growth of pathogens (e.g., Legionella)		5103

7.8102.5p Commissioning of system	The following will be checked once the system has been connected and filled: • Safety controls • Combustion safety and efficiency • Operational controls • Fuel and water leaks • Cycle unit • Local code requirements • Other system components (e.g., expansion tank, storage tank) Commissioning will be in accordance with manufacturer specifications and relevant industry standards	Ensure system functions safely and is designed with the lowest possible cost of ownership		5104
7.8102.5q Ambient carbon monoxide (CO)	All spaces with combustion appliances will have a CO alarm Locations of CO alarms in the space shall be in accordance with state law and local codes Ambient CO levels will be maintained under code-acceptable thresholds	Ensure worker, occupant, and building management staff health and safety		5105
7.8102.5r Education	Completed work will be reviewed Occupant/building operations staff/property manager will be educated on the safe and efficient operation and maintenance of the system, including: • Adjustment of water temperature • Operation of backflow preventer and pressure regulator • Importance of keeping operating manuals accessible	Educate occupant/building operations staff/property manager about the safe, efficient operation and maintenance of the system		5106

7.8102.6 Point-of-Use Water Heater

Topic: Water Heating

Subtopic: Installation and Replacement

Desired Outcome: Provide a safe and reliable hot water source that meets the needs of the occupant/building management/building operations staff at the lowest possible life cycle cost

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8102.6a Hazardous material removal	Health concerns in the removal and replacement of equipment (e.g., asbestos) will be identified Upon the discovery of hazardous material, written notification and contact information for regional EPA asbestos coordinator will be provided to appropriate people (e.g., occupant/property manager/building operations staff) Property manager will be asked to contract with an EPA-certified asbestos contractor to conduct abatement before decommissioning and replacement (property manager is responsible for abatement or remediation)	Remediate health hazards using EPA-certified contractors		5107
7.8102.6b Decommissioning	Decommission the applicable system components by completing the following in accordance with accepted industry procedures and practices: • Remove existing water heater and associated components • Safely disconnect and secure any abandoned utility (fuel and electric) connections • Safely disconnect and secure any abandoned waterlines as close to the main line as possible (avoid deadleg)	Ensure the health and safety of the worker/occupant/building management/building operations staff Preserve the integrity of the building and services Remove old equipment in a timely and efficient manner		5108
7.8102.6c Water supply	The volume and pressure of the water supplied will be sufficient to meet the needs of the water heater The methods utilized to determine pipe sizes shall be approved by the authority having jurisdiction	Provide sufficient volume and pressure of water to the fixture		5109
7.8102.6d New equipment installation	Point-of-use water heaters and associated components will be installed in accordance with local codes, accepted industry standards and practices, and manufacturer specifications	Ensure the health and safety of the worker/occupant/building management/building operations staff		5110

	Where conflicts occur between the code and manufacturer installation instructions, the more restrictive provisions shall apply			
7.8102.6e Temperature and pressure relief valve	Correct temperature and pressure relief valve will be installed in accordance with manufacturer specifications Equipment will be connected to properly sized discharge tube and run to a safe location no greater than 6" from the floor or as prescribed by local code (in the absence of local code, as prescribed by UPC)	Safely discharge excessive energy (pressure or temperature) from the water heater to a safe location		5111
7.8102.6f Dielectric unions (dielectric insulator)	Dielectric unions (dielectric insulator), if needed, will be installed in accordance with manufacturer specifications	Minimize corrosion between dissimilar metals		5112
7.8102.6g Stray voltage protection	Electrical connection to the water heating equipment should be made per manufacturer's instructions and per NFPA 70	Break the stray voltage electrical circuit through the appliance		5113
7.8102.6h Pipe insulation	All piping and fittings will be insulated with fixed insulation to IECC or ASHRAE 90.1, at a minimum	Reduce loss of heat		5114
7.8102.6i Power supply	Electric supply components will be installed in accordance with accepted industry standards and codes (NFPA 70 for electric); breaker for the circuit on which the heater is installed will be checked for proper ampacity	Provide sufficient power to the water heating element		5115
7.8102.6j Discharge water temperature	Discharge water temperature will be set not to exceed 120 °F or as prescribed by local code Install mixing valve when higher storage/generation temperatures are required	Ensure water temperature is low enough to prevent scalding Ensure water temperature is high enough to inhibit growth of pathogens (e.g., Legionella)		5116
7.8102.6k Commissioning of system	The following will be checked once the system has been connected and filled: • Safety controls • Operational controls • Water leaks • Cycle unit • Local code requirements	Ensure the system functions safely and is designed with lowest possible cost of ownership		5117

	Manufacturer specifications and all relevant industry standards will be met in commissioning			
7.8102.6l Education	Completed work will be reviewed Occupant/building operations staff/property manager will be educated on the safe and efficient operation and maintenance of the system, including: • Adjustment of water temperature • Importance of keeping operating manuals accessible	Educate occupant/building operations staff/property manager about the safe, efficient operation and maintenance of the system		5118

7.8102.7 Solar Water Heater

Topic: Water Heating

Subtopic: Installation and Replacement

Desired Outcome: Provide a safe and reliable hot water source that meets the needs of the occupant/building management/building operations staff at the lowest possible life cycle cost

Note: Solar water heating typically utilizes a backup source. Refer to other domestic hot water generation SWS (e.g., 7.8102.4, 7.8102.5, 7.8102.6, 7.8102.8) for the selected backup source for guidance on installation or removal of those systems

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

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8102.7a Hazardous material removal	Health concerns in the removal and replacement of equipment (e.g., asbestos) will be identified Upon the discovery of hazardous material, written notification and contact information for regional EPA asbestos coordinator will be provided to appropriate people (e.g., occupant/building operations staff/property manager) Property manager will be asked to contract with an EPA-certified asbestos contractor to conduct abatement before decommissioning and replacement (property manager is responsible for abatement or remediation)	Remediate health hazards using EPA-certified contractors		5119
7.8102.7b Decommissioning	Decommission the applicable system components by completing the following in accordance with	Ensure worker/occupant/building operations staff/property manager health and safety		5120

	accepted industry procedures and practices: • Remove old water heater and associated components • Safely disconnect and secure any abandoned utility (fuel and electric) connections	Preserve the integrity of the building and services Remove old equipment in a timely and efficient manner		
7.8102.7c Storage tank accessibility	Storage tank will be installed and plumbed to allow for inspection, maintenance, and replacement of the appliance and its components Anode rod will be accessible for replacement	Ensure the storage tank can be easily maintained and replaced		5121
7.8102.7d Solar collector accessibility	Solar collector will be installed and plumbed to allow for inspection, maintenance, and replacement of the appliance and its components There will be a path that allows the solar collector to be safely accessed without damaging the roof	Ensure solar collector can be easily maintained and replaced		5122
7.8102.7e Solar collector location	Installation of the solar collector will not exceed the structural capability of the building (e.g., dead load, wind load) Solar collectors will be sited to minimize shading factor and maximize solar gain	Maximize system performance with minimal negative impacts on the structure and occupant/building management/building operations staff		5123
7.8102.7f New equipment installation	Solar collectors, storage tank, and associated components will be installed in accordance with local codes, accepted industry standards and practices, and manufacturer specifications Roof penetrations will be sealed in conformance with the applicable code adopted by the jurisdiction	Ensure the health and safety of the worker/occupant/building operations staff/property manager Preserve the integrity of the building Maximize performance		5124
7.8102.7g Freeze protection	The system will incorporate freeze protection for applicable climates, including, but not limited to, closed glycol loops, drain back systems, supplemental heat, or other methods, as approved by local code and manufacturer specifications	Prevent freezing liquid in pipes in cold weather climates		5125

7.8102.7h Drain pan	In instances where a leak could cause damage, a drain pan will be installed under the storage tank in accordance with manufacturer specifications and the following criteria: • Connected to 3/4" drain line or larger to tapping on pan • Run to drain, pump, or daylight	Collect and safely dispose of water escaping from the storage tank		5126
7.8102.7i Temperature and pressure relief valve	Correct temperature and pressure relief valve will be installed in accordance with manufacturer specifications Storage tank will be connected to properly sized discharge tube and run to a safe location no greater than 6" from the floor or as prescribed by local code (in the absence of local code, as prescribed by UPC) Solar collectors will be connected to properly sized discharge tube and run to a safe location, as prescribed by local code (in the absence of local code, as prescribed by UPC)	When applicable, safely discharge excessive energy (pressure or temperature) from the storage tank and collectors to a safe location		5127
7.8102.7j Dielectric unions (dielectric insulator)	Dielectric unions (dielectric insulator), if needed, will be installed in accordance with manufacturer specifications	Minimize corrosion between dissimilar metals		5128
7.8102.7k Stray voltage protection	When electric equipment (e.g., pumps motors) is used in conjunction to or connected to the solar water heater, the electrical connection should be made per manufacturer's instructions and per NEC (NFPA 70)	Break the stray voltage electrical circuit through the appliance		5129
7.8102.7l Backflow prevention	Backflow prevention will be installed in accordance with manufacturer specifications and all applicable codes Backflow devices shall be tested by a certified backflow assembly tester at the time of installation, repair, or relocation, and not less than on an annual schedule or more often where required by local code	Protect potable water supply from contamination		5130

7.8102.7m Pipe insulation	All piping and fittings will be insulated with fixed insulation to IECC or ASHRAE 90.1, at a minimum Pipe insulation exposed to the sun will be protected from ultraviolet radiation and other damage	Reduce line losses Prevent insulation from deteriorating		5131
7.8102.7n Required ventilation and clearances	Ventilation and clearances will be provided under solar collectors in accordance with manufacturer specifications and local code	Prevent damage to solar collectors, mounts, and roof		5132
7.8102.7o Electric supply	Electric supply components will be installed to accepted industry standards and codes in accordance with NEC (NFPA 70) Required energy input to the pumps and controls will be in accordance with manufacturer specifications	Provide sufficient electricity to pumps and solar water heating systems		5133
7.8102.7p Discharge water temperature	Discharge water temperature will be set not to exceed 120 °F or as prescribed by local code Install mixing valve when higher storage/generation temperatures are required	Ensure water temperature is low enough to prevent scalding		5134
7.8102.7q Commissioning of system	System design criteria will be checked once the system has been connected and filled, including: • Safety controls • Operational controls • Water leaks • Cycle unit modes (e.g., freeze protection, high limit, collection, idle) • Other system components (e.g., expansion tank, storage tank) Manufacturer specifications and all relevant industry standards will be met in commissioning	Ensure the system functions safely and is designed with the lowest possible cost of ownership		5135
7.8102.7r Education	Completed work will be reviewed Occupant/building operations staff/property manager will be educated on the safe and efficient operation and maintenance of the system, including: • Operational modes • Adjustment of water temperature	Educate the occupant/building operations staff/property manager about the safe, efficient operation and maintenance of the system		5136

	• Adjustment of tempering valve • Tank maintenance (e.g., anodes, temperature, and pressure relief valve) • Fluid maintenance and replacement • Solar collector maintenance (e.g., cleaning the collectors, checking gaskets, and mounts) • Shade prevention, including trimming nearby trees and vegetation; inform manager/owner/staff that new construction of high-rise buildings on the south side of property may cause shadows, limiting the effectiveness of the solar thermal system • Operation of backflow preventer and pressure regulator • Importance of keeping operating manuals accessible			

7.8102.8 Heat Pump Water Heater

Topic: Water Heating

Subtopic: Installation and Replacement

Desired Outcome: Provide a safe and reliable hot water source that meets the needs of the occupant/building management/building operations staff at the lowest possible life cycle cost

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

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8102.8a Hazardous material removal	Health concerns in the removal and replacement of equipment (e.g., asbestos) will be identified Upon the discovery of hazardous material, written notification and contact information for regional EPA asbestos coordinator will be provided to appropriate people (e.g., occupant/building	Remediate health hazards using EPA-certified contractors		5137

	operations staff/property manager) Property manager will be asked to contract with an EPA-certified asbestos contractor to conduct abatement before decommissioning and replacement (property manager is responsible for abatement or remediation)			
7.8102.8b Decommissioning	Decommission the applicable system components by completing the following in accordance with accepted industry procedures and practices: • Remove old water heater and associated components • Seal any unused chimney openings • Safely disconnect and secure any abandoned utility (fuel and electric) connections at source	Ensure the health and safety of the worker/occupant/building management/building operations staff Preserve the integrity of the building and services Remove old equipment in a timely and efficient manner		5138
7.8102.8c Equipment accessibility	A level working space not less than 30" in length and 30" in width shall be provided in front of the control side to service an appliance Water heaters shall be installed in accordance with their listings and the manufacturer's installation instructions Appliance will be installed and plumbed to allow for inspection, maintenance, and replacement of the appliance and its components, without disturbing any installed equipment, controls, piping, and components, other than what requires repair/replacement Anode rod will be accessible for replacement	Ensure the appliance can be easily maintained and replaced		5139
7.8102.8d Equipment location	Appliance will be located to minimize noise impact Appliance will be located to maximize efficient operation and auxiliary benefits (e.g., dehumidification)	Maximize operation of the appliance with minimal negative impact on building management/building operations staff		5140

7.8102.8e New equipment installation	A new water heater and associated components will be installed in accordance with local codes, accepted industry standards and practices, and manufacturer specifications In instances where conflicts occur between the code and the manufacturer's installation instructions, the more restrictive provisions shall apply In instances where a leak could cause damage, a drain pan will be installed under the storage tank in accordance with manufacturer specifications and the following criteria: • Connected to 3/4" drain line or larger to tapping on pan • Run to drain, pump, or daylight	Ensure the health and safety of the worker/occupant/building management/building operations staff		5141
7.8102.8f Drain pan	In instances where a leak could cause damage, a drain pan will be installed in accordance with manufacturer specifications and the following criteria (Uniform Plumbing Code 5.10.7, IRC 20801.5.1): • Connected to 3/4" drain line or larger to tapping on pan • Run to drain, pump, or daylight	Collect and safely dispose of water escaping from the appliance		5142
7.8102.8g Temperature and pressure relief valve	Correct temperature and pressure relief valve will be installed in accordance with manufacturer specifications Equipment will be connected to properly sized discharge tube and run to a safe location no greater than 6" from the floor or as prescribed by local code (in the absence of local code, as prescribed by UPC) There will be no shut off valve installed on the discharge tube	Safely discharge excessive energy (pressure or temperature) from the appliance to a safe location		5143
7.8102.8h Dielectric unions (dielectric insulator)	Dielectric unions (dielectric insulator), if needed, will be installed in accordance with manufacturer specifications	Minimize corrosion between dissimilar metals		5144

7.8102.8i Stray voltage protection	Electric water heating equipment should be installed per the NEC (NFPA70)	Break the stray voltage electrical circuit through the appliance		5145
7.8102.8j Backflow prevention	Backflow prevention will be installed in accordance with manufacturer specifications and all applicable codes Backflow devices shall be tested by a certified backflow assembly tester at the time of installation, repair, or relocation, and not less than on an annual schedule or more often where required by local code	Protect the water supply from contamination		5146
7.8102.8k Pressure verification	Water pressure and volume capacity of the building will be verified as sufficient to be in accordance with manufacturer specifications A pressure regulator or booster pump will be installed as required	Provide proper water pressure to the appliance		5147
7.8102.8l Pipe insulation	All piping and fittings will be insulated with fixed insulation to IECC or ASHRAE 90.1, at a minimum	Reduce line losses		5148
7.8102.8m Required air	Ventilation and clearances for adequate heat transfer will be provided in accordance with manufacturer specifications	Ensure adequate air for heat exchange across the coil		5149
7.8102.8n Electric supply	Electric supply components will be installed to accepted industry standards and codes in accordance with NEC (NFPA70) Energy input required by the appliance will be in accordance with manufacturer specifications	Provide sufficient electricity to the water heater		5150
7.8102.8o Discharge water temperature	Discharge water temperature will be set not to exceed 120 °F or as prescribed by local code Install mixing valve when higher storage/generation temperatures are required	Ensure water temperature is low enough to prevent scalding Ensure water temperature is high enough to inhibit growth of pathogens (e.g., Legionella, etc.)		5151
7.8102.8p Commissioning of system	The following will be checked once the system has been connected and filled: • Safety controls • Operational controls • Water leaks • Cycle unit through modes • Filter	Ensure the system functions as designed with the lowest possible cost of ownership		5152

	• Other system components (e.g., expansion tank, storage tank) • Temperature set point Manufacturer specifications and all relevant industry standards will be met in commissioning			
7.8102.8q Education	Completed work will be reviewed Occupant/building operations staff/property manager will be educated on the safe and efficient operation and maintenance of the system, including: • Adjustment of water temperature • Operation of backflow preventer and pressure regulator • Filter replacemen • Importance of keeping operating manuals accessible	Educate the occupant/building operations staff/property manager about the safe, efficient operation and maintenance of the system		5153

7.8102.9 Non-Fired Storage Tank

Topic: Water Heating

Subtopic: Installation and Replacement

Desired Outcome: Provide safe and reliable hot water storage that meets the needs of the occupant/building management/building operations staff at the lowest possible life cycle cost

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8102.9a Hazardous material removal	Health concerns in the removal and replacement of equipment (e.g., asbestos) will be identified Upon the discovery of hazardous material, written notification and contact information for regional EPA asbestos coordinator will be provided to appropriate people (e.g., occupant/building operations staff/property manager) Property manager will be asked to contract with an EPA-certified asbestos contractor to conduct abatement before decommissioning and	Remediate health hazards using EPA-certified contractors		5154

	replacement (property manager is responsible for abatement or remediation)			
7.8102.9b Decommissioning	Decommission the applicable system components by completing the following in accordance with accepted industry procedures and practices: • Remove old water heater and associated components • Seal any unused chimney openings • Safely disconnect and secure any abandoned utility (fuel and electric) connections	Ensure the health and safety of the worker/occupant/building management/building operations staff Preserve the integrity of the building and services Remove old equipment in a timely and efficient manner		5155
7.8102.9c Site security	Work site will be secured to prevent unauthorized entry Temporarily disconnected equipment will be locked up and tagged out All trash and unused materials will be removed from work site daily	Protect the occupant from exposure to potential hazards		5156
7.8102.9d Equipment accessibility	Storage tank will be installed and plumbed to allow for inspection, maintenance, and replacement of the tank and its components Anode rod, when present, will be accessible for replacement	Ensure the storage tank can be easily maintained and replaced		5157
7.8102.9e Storage tank location	Storage tank will be located to maximize efficient operation of the water heating system	Maximize operation of the water heating system		5158
7.8102.9f Storage tank installation	Verify storage tank size will meet the building water requirements A new storage tank and associated components will be installed in accordance with accepted industry standards and practices and manufacturer specifications Storage tanks will be installed level, with seismic bracing (when needed) and in a manner to prevent rust and corrosion Storage tank will be installed on a housekeeping pad Storage tanks shall be placed in a location that does not obstruct building egress or access, as	Ensure the health and safety of the worker/occupant/building management/building operations staff		5159

	required by local codes adopted by the AHJ			
7.8102.9g Drain pan	A drain pan will be installed in accordance with storage tank manufacturer specifications and the following criteria: • Connected to 3/4" drain line or larger to tapping on pan • Run to drain, pump, or daylight	Collect and safely dispose of water escaping from the storage tank		5160
7.8102.9h Temperature and pressure relief valve	Correct temperature and pressure relief valve will be installed in accordance with manufacturer specifications Storage tank will be connected to properly sized discharge tube and run to a safe location no greater than 6" from the floor or as prescribed by local code (in the absence of local code, as prescribed by UPC)	Safely discharge excessive energy (pressure or temperature) from the storage tank to a safe location		5161
7.8102.9i Dielectric unions (dielectric insulator)	Dielectric unions (dielectric insulator), if needed, will be installed in accordance with manufacturer specifications	Minimize corrosion between dissimilar metals		5162
7.8102.9j Stray voltage protection	Electrical connection to the water heating equipment should be made per manufacturer's instructions and per NEC (NFPA 70)	Break the stray voltage electrical circuit through the appliance		5163
7.8102.9k Insulation	All piping and fittings will be insulated with fixed insulation to IECC or ASHRAE 90.1, at a minimum Tanks will be insulated to a minimum of R-12.5	Reduce heat loss from the storage tank and pipe		5164
7.8102.9l Electric components	Electric components will be installed to accepted industry standards and codes in accordance with NEC (NFPA 70)	Provide electricity to the storage tank electric control components		5165
7.8102.9m Discharge water temperature	Discharge water temperature will be set not to exceed 120 °F or as prescribed by local code Install mixing valve when higher storage/generation temperatures are required	Ensure water temperature is low enough to prevent scalding Ensure water temperature is high enough to inhibit growth of pathogens (e.g., Legionella, etc.)		5166
7.8102.9n Gauges	Temperature and pressure gauges on storage tank will be installed and visible	Provide information for safe and effective operation of water heating system		5167

7.8102.9o Valves	Valves will be installed to isolate tank from water heating system and to allow for bypass in multiple tank systems	Allow for easy removal and maintenance of the tank		5168
7.8102.9p Commissioning of system	The following will be checked once the system has been connected and filled: • Safety controls • Operational controls • Valves • Water leaks • Temperature set point Manufacturer specifications and all relevant industry standards will be met in commissioning	Ensure the system functions safely and is designed with the lowest possible cost of ownership		5169
7.8102.9q Education	Completed work will be reviewed Occupant/building operations staff/property manager will be educated on the safe and efficient operation and maintenance of the system, including: • Adjustment of water temperature • Proper use of isolation valves • Need for inspection and replacement of anode rod • Importance of keeping operating manuals accessible	Educate the occupant/building operations staff/property manager about the safe, efficient operation and maintenance of the system		5170

7.8103.3 Purging

Topic: Water Heating

Subtopic: Maintenance/Inspection

Desired Outcome: Damage to the equipment will be prevented by effectively removing all air from the water heating system

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8103.3a System analysis	Water piping will be analyzed to identify air collection points (e.g., highpoints, deadheads, side-plumbed tanks, large pumps)	Ensure purging will be effective		5171
7.8103.3b Order	Purging will be done in the following order: • New equipment • Entire system • Verify equipment	Ensure purging will be effective		5172

7.8103.3c Purge new equipment	Equipment will be purged in accordance with manufacturer specifications	Effectively purge new equipment		5173
7.8103.3d Purge system	System will be manually purged using water pressure Auto air vents will not be relied on for purging Purging of air collection points (e.g., highpoints, deadheads, side-plumbed tanks, large pumps) will be verified	Effectively purge system		5174
7.8103.3e Verify purging of new equipment	Equipment will be purged in accordance with manufacturer specifications	Verify equipment is purged		5175
7.8103.3f Energize system	System will be energized and checked for air noise	Conduct final verification of purge		5176

7.8103.4 Rooftop Potable Water Storage Tanks ("Standpipe" or "Gravity" Tanks)

Topic: Water Heating

Subtopic: Maintenance/Inspection

Desired Outcome: Ensure rooftop potable water storage tanks (seen in older high-rise buildings, typically made of wood, used to provide potable cold water to building via gravity, and filled by ground floor pumps) are properly maintained

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8103.4a Cleaning	Drain, clean, disinfect, and flush storage tank with chlorine solution or equivalent no less than annually	Ensure water quality Maintain system durability		5177
7.8103.4b Tanks floats	Inspect tank floats annually, and lubricate and repair, as needed	Maintain proper operation of float and ground floor pumps		5178
7.8103.4c Tank sealing	Repair and caulk any tank cracks and holes Carefully tighten vertical slats, as necessary Fill and pressure test after completion of sealing	Prevent water leakage Maintain water quality and prevent contamination Ensure system durability		5179
7.8103.4d Freeze protection	If large water mass and regular water flow is inadequate for freeze protection in cold climates, minimize freezing by implementing tank insulation, electric resistance heating, or hydronic/steam coils, as needed	Prevent water from freezing		5180

7.8103.5 Water Softening/Conditioning

Topic: Water Heating

Subtopic: Maintenance/Inspection

Desired Outcome: Water softened/conditioned to a range that meets the needs of the occupant/building management/building operations staff without damaging the water system

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8103.5a Test water quality	Major water parameters (e.g., pH, iron, sodium, manganese) will be measured and compared to state and national standards, such as American Water Works Association	Determine water quality to choose appropriate treatment system		5181
7.8103.5b Location	Water softeners/conditioners will be installed in the cold water supply of water heater	Ensure longevity of the system Ensure sodium content in drinking water is not increased		5182
7.8103.5c Selection and installation	A water treatment system capable of remedying identified water quality issue will be installed Drinking water treatment units shall comply with local water standards and requirements	Water softened/conditioned to a range that meets the needs of the occupant/building management/building operations staff without damaging the water system		5183
7.8103.5d Valves	Isolation valves and bypass piping will be installed on water treatment systems	Water treatment system can be isolated for maintenance or bypass		5184
7.8103.5e Stray voltage protection	Electrical connection to the water equipment should be made per manufacturer's instructions and per NEC (NFPA 70)	Break the stray voltage electrical circuit through the appliance		5185
7.8103.5f Storage of salt	Salts for treating the system will be stored in a cool and dry environment and away metal solids	Prevent corrosion		5186
7.8103.5g Commissioning	Treatment levels (e.g., 60-120 parts per million calcium carbonate) will be set in accordance with the National Association of Corrosion Engineers (NACE TPC 7) System will be checked for leaks System will be purged	Ensure proper function of water treatment system Ensure water does not damage pipes or tanks due to overtreatment		5187
7.8103.5h Commissioning	An operation manual and educational materials from NACE will be provided to property manager	Educate occupant/ building operations staff/property manager about the safe, efficient operation and maintenance of the system		5188

7.8103.6 Operation Manual

Topic: Water Heating

Subtopic: Maintenance/Inspection

Desired Outcome: The occupant/ building operations staff/property manager will properly maintain the water heating system throughout the life of the equipment

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8103.6a Operation manual	An operation manual that details inspection and maintenance of the water heating system will be provided to the property manager Operation manual will have a table of contents and will be tabbed and in a ringed binder	Educate the occupant/ building operations staff/property manager about maintenance of the system		5189
7.8103.6b Content	Operation manual will include information on: • Safety • Installer contact details • Manufacturer specifications • Warranties • Hot water source • –Boilers • –Storage water heater • –Tankless water heaters • Storage tanks • Pumps • Piping • –Materials • –Location • –Pipe tracing • Valves • Controls • –Safety • –Operational • –Recirculation • Sensors • Gauges • Combustion venting • Wiring • Insulation Installer will complete pertinent sections	Ensure the operation manual provides all necessary information		5190
7.8103.6c Additional resources	Refer to the commissioning and education subsection of the SWS, when present, for the applicable measure being installed	Provides guidance for detailed development		5191

7.8103.7 Crossover Due to a Backflow into the Cold Water Supply

Topic: Water Heating

Subtopic: Maintenance/Inspection

Desired Outcome: Minimize energy and water waste to the lowest possible life cycle cost

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8103.7a 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 before decommissioning and replacement (occupant is responsible for abatement or remediation)	Remediate health hazards using EPA-certified contractors		5192
7.8103.7b Installation	Check valve will be installed on the cold water supply to the water heating equipment A thermal expansion tank will be installed, if not present	Eliminate crossover		5193
7.8103.7c Commissioning	Water pressure downstream of the check valve will be verified Expansion tank charge will be verified or set in accordance with SWS 7.8104.8 Domestic Hot Water Expansion Tank (Potable Water)	Ensure proper operation		5194

7.8103.8 Crossover Due to Improper Plumbing Connections Between Multiple Storage Tanks

Topic: Water Heating

Subtopic: Maintenance/Inspection

Desired Outcome: Minimize energy and water waste to the lowest possible life cycle cost

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8103.8a 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,	Remediate health hazards using EPA-certified contractors		5195

	including contact information for regional EPA asbestos coordinator Occupant will be asked to contract with an EPA-certified asbestos contractor to conduct abatement before decommissioning and replacement (occupant is responsible for abatement or remediation)			
7.8103.8b Installation	Spring-loaded check valve will be installed on the cold water supply to the non-recirculating tank System will be purged Work will be completed in an aesthetically pleasing manner (e.g., repairs made to structure and finished surfaces)	Eliminate crossover		5196
7.8103.8c Commissioning	Water pressure downstream of the check valve will be verified	Ensure proper operation		5197

7.8103.9 Crossover Due to Missing Check Valve in Recirculation of Hot Water Return

Topic: Water Heating

Subtopic: Maintenance/Inspection

Desired Outcome: Minimize energy and water waste to the lowest possible life cycle cost

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8103.9a 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 before decommissioning and replacement (occupant is responsible for abatement or remediation)	Remediate health hazards using EPA-certified contractors		5198
7.8103.9b Installation	Spring-loaded check valve will be installed on the hot water return of a recirculation loop immediately upstream of the storage tank	Eliminate crossover		5199

	System will be purged Valves will be added to the recirculation line to purge the system if needed Work will be completed in an aesthetically pleasing manner (e.g., repairs made to structure and finished surfaces)			
7.8103.9c Commissioning	Water pressure downstream of the check valve will be verified	Ensure proper operation		5200

7.8104.1 Mixing Valves

Topic: Water Heating

Subtopic: Distribution

Desired Outcome: Safe and reliable hot water delivery that meets the needs of the occupant/building management/building operations staff at the lowest possible life cycle cost

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8104.1a 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 before decommissioning and replacement (occupant is responsible for abatement or remediation)	Remediate health hazards using EPA-certified contractors		5201
7.8104.1b Removal	Existing mixing valves will be hydraulically isolated (shut isolation valves) and drained before removal Existing mixing valves will be disconnected from electricity before removal	Safely remove the existing mixing valve		5202
7.8104.1c Installation	Mixing valve will be installed in accordance with manufacturer specifications and local code requirements	Ensure the mixing valve is properly installed Allow proper and effective function of the valve		5203

	Controls, sensors, wiring, and other components will be installed in a manner that does not expose occupant/building operations staff/property manager to hazardous conditions When controls are using low voltage, the low voltage and line voltage wiring will be separated Controls, sensors, wiring, and other components will be installed in a manner that does not pose an unnecessary risk to the integrity of the installation (e.g., wiring, sensors)	Ensure long-term safety and durability of components		
7.8104.1d Location	Mixing valves will be installed at as many locations as necessary to ensure delivery of safe and adequate hot water Mixing valve will be installed with a heat trap or at a distance from heat sources sufficient enough to prevent scaling or damage to the valve	Ensure water temperature is low enough to prevent scalding at all locations Ensure water temperature is high enough to inhibit growth of pathogens (e.g., Legionella) Ensure the valve does not fail prematurely		5204
7.8104.1e Mounting	Mixing valve will be mounted in accordance with manufacturer specifications	Prevent the mixing valve from coming loose		5205
7.8104.1f Accessibility	Mixing valve will be installed and plumbed to allow for inspection, maintenance, and replacement of the valve	Ensure the mixing valve can be easily maintained and replaced		5206
7.8104.1g Isolation valve	Isolation valves will be installed to isolate mixing valve	Allow for easy removal and maintenance of the mixing valve		5207
7.8104.1h Check valve	Check valve will be installed on the cold and hot water supply lines	Prevent crossover		5208
7.8104.1i Temperature gauges	Temperature gauges will be installed on hot, cold, and tempered supply water lines within line of sight of the mixing valve	Allow verification of proper operation of the mixing valve		5209
7.8104.1j Sensors	Controls and sensors will be installed or reconnected in accordance with design specifications When controls are using low voltage, the low voltage and line voltage wiring will be separated Installer will understand the function of the mixing valve as part of the hot water control system	Ensure proper function of the mixing valve		5210

7.8104.1k Discharge water temperature	Discharge water temperature will be set not to exceed 120 °F or as prescribed by local code Install mixing valve when higher storage/generation temperatures are required	Ensure water temperature is low enough to prevent scalding Ensure water temperature is high enough to inhibit growth of pathogens (e.g., Legionella)		5211
7.8104.1l Commissioning	The following will be checked: • System filled and purged • Water leaks • Valves open • Isolation and check valve orientation correct • Function of mixing valves across full range of incoming hot water temperatures Relevant information will be added to operation manual	Verify operation of the mixing valve		5212
7.8104.1m Education	Completed work will be reviewed Occupant/building operations staff/property manager will be educated on the safe and efficient operation and maintenance of the system, including: • Adjustment of water temperature • Proper use of isolation valves • Importance of keeping operating manuals accessible	Educate occupant/building operations staff/property manager about the safe, efficient operation and maintenance of the system		5213

7.8104.2 Crossover Due to a Single Lever Valve or a Failed Valve

Topic: Water Heating

Subtopic: Distribution

Desired Outcome: Minimize energy and water waste to the lowest possible life cycle cost

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8104.2a 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	Remediate health hazards using EPA-certified contractors		5214

	Occupant will be asked to contract with an EPA-certified asbestos contractor to conduct abatement before decommissioning and replacement (occupant is responsible for abatement or remediation)			
7.8104.2b Installation	Check valves will be installed on the hot and cold water supply lines upstream of the valve	Eliminate crossover		5215
7.8104.2c Commissioning	Water pressure at the fixture will be verified	Ensure proper operation		5216

7.8104.3 Piping

Topic: Water Heating

Subtopic: Distribution

Desired Outcome: Provide safe and reliable hot water that meets the needs of the occupant/building management/building operations staff at the lowest possible life cycle cost

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8104.3a Hazardous material removal	Health concerns in the removal and replacement of equipment (e.g., asbestos) will be identified Upon the discovery of hazardous material, written notification and contact information for regional EPA asbestos coordinator will be provided to appropriate people (e.g., occupant/building operations staff/property manager) Property manager will be asked to contract with an EPA-certified asbestos contractor to conduct abatement before decommissioning and replacement (property manager is responsible for abatement or remediation)	Remediate health hazards using EPA-certified contractors		5217
7.8104.3b Removal	Visible abandoned piping will be removed Obsolete but inaccessible piping will be capped as close as possible to point of no access	Allow for proper future maintenance		5218
7.8104.3c Location	Piping will be installed to minimize length Hot water piping will be purposely located to allow for insulation of	Ensure piping is safe, efficient, durable, and accessible		5219

	each individual pipe (e.g., no bundling) Piping will be located with the following priority: • Within conditioned space • Within the building • Outdoor air • Below ground (insulated and sleeved) Tracer lines will be installed and labeled when piping is installed below ground or when the pipe is hidden within the building Piping will not be placed in locations prohibited by adopted buildings codes; such locations include, but are not limited to, exit stairs enclosures, exit passageways, and electrical equipment rooms Piping will be installed to protect occupant/building management/building operations staff from hot water pipes			
7.8104.3d Insulation	All piping and fittings will be insulated with fixed insulation to IECC or ASHRAE 90.1, at a minimum Tanks will be insulated to a minimum of R-12.5 Insulation will be protected from damage (e.g., protected from underground water, contact, friction from pipe hangers, woodpeckers, ultraviolet radiation)	Prevent the pipe from freezing Minimize heat loss from the pipes Reduce the risk of moisture damage		5220
7.8104.3e Friction loss	Friction loss will be minimized using the following criteria: • Smooth piping • Minimized number of fittings • Sweeps will be selected instead of 90° elbows • Full port valves	Maximize effective delivery of water Minimize the energy use of the pump Minimize pipe damage		5221
7.8104.3f Dissimilar metals	Dissimilar metals shall be connected in a manner to prevent galvanic corrosion When connecting nonferrous metal piping to existing ferrous piping, dielectric unions (dielectric insulator) will be installed in accordance with manufacturer specifications	Minimize corrosion between dissimilar metals		5222

	Alternatively, if dielectric unions are not required by code, consider using a plastic-lined steel nipple a minimum of 4" long to connect the two piping systems to separate dissimilar metals			
7.8104.3g Bracing and hangers	Piping, fixtures, appliances, and appurtenances shall be adequately supported in accordance with the manufacturer's installation instructions and in accordance with the authority having jurisdiction	Ensure the piping is safe and durable		5223
7.8104.3h Stray voltage protection	Piping will be bonded and grounded as required by NEC (NFPA 70)	Eliminate stray voltage from piping		5224
7.8104.3i Commissioning	Piping will be charged and checked for leaks	Ensure the piping and fittings operate as designed		5225

7.8104.4 Pumps

Topic: Water Heating

Subtopic: Distribution

Desired Outcome: Provide safe and reliable hot water that meets the needs of the occupant/building management/building operations staff at the lowest possible life cycle cost

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8104.4a 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 before decommissioning and replacement (occupant is responsible for abatement or remediation)	Remediate health hazards using EPA-certified contractors		5226
7.8104.4b Removal	Old pumps will be hydraulically isolated (valves shut) and drained before removal Old pumps will be disconnected from electricity before removal	Safely remove the old pump		5227

7.8104.4c Installation and location	Pump will be installed and plumbed to allow for inspection, maintenance, and replacement of the pump	Ensure the pump can be easily maintained and replaced		5228
7.8104.4d Insulation	Pumps will not be insulated	Prevent the pump from overheating		5229
7.8104.4e Valves	Valves will be installed to isolate pump from water heating system	Allow for easy removal and maintenance of the pump		5230
7.8104.4f Controls and sensors	Controls and sensors will be installed or reconnected in accordance with design specifications Installer will understand the control system When controls are using low voltage, the low voltage and line voltage wiring will be separated	Ensure proper function of the water heating system		5231
7.8104.4g Gauges	Pressure gauges will be installed to measure suction, discharge, and pressure differential	Verify proper operation of the pump		5232
7.8104.4h Mounting	Pumps will be mounted in accordance with manufacturer specifications	Prevent the pump from coming loose Minimize vibration		5233
7.8104.4i Laminar flow	Pumps will be installed in accordance with manufacturer specifications with sufficient straight line piping before and after the pump	Minimize pump cavitation Ensure proper operation of the pump		5234
7.8104.4j Electric	Damaged wiring will be replaced Wiring will be protected from physical damage and water sources Polarity of pump wiring will be verified before starting the pump	Prevent damage to the pump Ensure pump is properly wired		5235
7.8104.4k Drain/purge valve	A drain spigot will be installed in close proximity of the discharge end of the pump	Allow the piping to be purged of air		5236
7.8104.4l Dissimilar metals	When connecting nonferrous metal pump to existing ferrous piping, a plastic-lined steel nipple a minimum of 4" long will be installed to connect the two piping systems	Minimize corrosion between dissimilar metals		5237
7.8104.4m Pump materials	Pump will be made with metals suitable for potable water, such as bronze or stainless steel	Ensure safe domestic water for building occupants		5238
7.8104.4n Stray voltage protection	Motors will be grounded per NEC (NFPA 70)	Eliminate stray voltage		5239
7.8104.4o Commissioning	The following will be checked before energizing the pump:	Ensure the pump operates as designed		5240

	• System filled and purged • Safety controls present • Valves open • Pump and check valve properly oriented • Shipping bolts removed The following will be checked once pump is energized: • System purge complete • Rotation • Function of safety controls • Integration of system controls • Water leaks • Operation of pressure gauges Manufacturer specifications will be met in commissioning			

7.8104.5 Gauges

Topic: Water Heating

Subtopic: Distribution

Desired Outcome: Gauges will provide accurate information to allow for safe and reliable operation of water heating system

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8104.5a System analysis	System design specifications will be reviewed and understood	Properly install the correct gauges in the correct location		5241
7.8104.5b Calibration	Calibration for analog gauges will be verified Digital gauges will be calibrated	Provide accurate measurements		5242
7.8104.5c Range	A gauge will be selected with an appropriate range for the design specifications	Provide accurate measurement		5243
7.8104.5d Dissimilar metals	When connecting a nonferrous metal pump to existing ferrous piping, a plastic-lined steel nipple a minimum of one pipe diameter in length will be installed to connect the two pipes	Minimize corrosion between dissimilar metals		5244
7.8104.5e Accessibility	Gauges will be selected that can be easily read for light conditions Gauges will be installed so they can be easily read (e.g., not facing the wall)	Allow for easy reading		5245
7.8104.5f Location	Temperature gauges will be installed so they are not adversely affected by	Provide accurate measurements		5246

	other equipment through heat conduction Pressure gauges will be installed so they are not adversely affected by turbulent flow and vibration			
7.8104.5g Placement: surface-mount thermometer	Thermocouple for digital gauges will be installed tightly to the pipe Thermocouple for digital gauges will be wrapped with insulation to exclude ambient temperature	Provide accurate measurements		5247
7.8104.5h Placement: wet-mount thermometer	Gauges will be installed so they are not in an air pocket (e.g., install on side of pipe, not on top of side-plumbed tanks)	Measure fluid temperature, not air temperature		5248
7.8104.5i Installation	Gauges will be installed in accordance with manufacturer specifications An isolation valve will be installed to allow pressure gauges to be replaced Gauges will be installed in a location (where possible) that allows instructions to be easily read without the need of a ladder or step stool	Provide accurate measurements		5249

7.8104.6 Recirculation System Temperature Modulation Controls

Topic: Water Heating

Subtopic: Distribution

Desired Outcome: Safe and reliable hot water delivery system that meets the needs of occupant/building management/building operations staff at the lowest possible life cycle cost

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8104.6a 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 before decommissioning and replacement (occupant is responsible for abatement or remediation)	Remediate health hazards using EPA-certified contractors		5250

7.8104.6b Electric safety	Electric circuit will be disconnected before removing or installing controls	Ensure the health and safety of the worker/occupant/building management/building operations staff		5251
7.8104.6c Removal of controls	Decommissioned controls will be removed or labeled as abandoned	Allow system to be maintained		5252
7.8104.6d Mounting	Controls will be mounted on a stable and sturdy surface Controls will be installed in accordance with manufacturer specifications	Ensure safe and effective installation		5253
7.8104.6e Identification	Controls will be clearly identified or labeled to identify associated equipment ("this device controls boiler #2," etc) Location and purpose of controls for water heating equipment (e.g., boiler, storage type water heater) will be clearly identified or labeled	Allow system to be maintained		5254
7.8104.6f Integration with other system controls	Purpose and function of controls integral to water heating equipment (including input data from sensors) will be identified before installing additional controls Existing hot water supply set points will be logged Function and set point of anti-scald mixing valve will be determined Location and interaction of sensors and controls will be sketched or described Location of sensors and interaction of final control configuration will be sketched or described	Maintain the integrity of the hot water system and components		5255
7.8104.6g Installation	Sensors and controls will be installed in accordance with manufacturer specifications When controls are using low voltage, the low voltage and line voltage wiring will be separated Controls, sensors, wiring, and other components will be installed in a manner that does not expose occupant/ building operations staff/property manager to hazardous conditions Controls, sensors, wiring, and other components will be installed in a manner that does not pose an	Allow proper and effective function of the controls Ensure long-term safety and durability of components		5256

	unnecessary risk to the integrity of the installation (e.g., wiring, sensors)			
7.8104.6h Mounting	Controls will be mounted on a stable and sturdy surface Controls will be installed in accordance with manufacturer specifications	Ensure safe and effective installation		5257
7.8104.6i Site security	All trash and unused materials will be removed from work site daily	Protect the occupant from exposure to potential hazards		5258
7.8104.6j Commissioning	Modulation of hot water supply temperature will be verified in accordance with settings Proper operation of anti-scald mixing valve, if present, will be verified Transmission of monitored data (or data logging) will be verified in accordance with settings Operator/owner manual will be updated or completed with site-specific data	Ensure proper and effective function of the controls Allow for long-term maintenance or monitoring of the system		5259
7.8104.6k Education	Operator/owner manual will be provided Site staff will be educated Manual and education will include: • Purpose of control system • How to identify expected control modes • How to identify system or component failure modes • Which failures to fix • Which failures to have a plumber fix • Which failures require a different specialist • Contact information for controls installer/manufacturer	Educate occupant/building operations staff/property manager about the safe, efficient operation and maintenance of the system		5260

7.8104.7 Recirculation System Demand-Controlled Pump

Topic: Water Heating

Subtopic: Distribution

Desired Outcome: Safe and reliable hot water delivery system that meets the needs of the occupant/building management/building operations staff at the lowest possible life cycle cost

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		

7.8104.7a 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 before decommissioning and replacement (occupant is responsible for abatement or remediation)	Remediate health hazards using EPA-certified contractors		5261
7.8104.7b Pump removal	SWS 7.8104.4 Pumps will be used Electricity to the pump will be turned off Water to recirculation pump will be shut off (using isolation valves if possible) and section of water line with the pump will be drained Existing pump will be removed safely	Safely remove the existing pump		5262
7.8104.7c Removal of controls	Decommissioned controls will be removed or labeled as abandoned	Allow the system to be maintained		5263
7.8104.7d Pump installation	SWS 7.8104.4 Pumps will be used, particularly the parts about isolation valves and drain/purge valve Demand controlled pump will be installed in accordance with manufacturer specifications	Ensure safe and effective installation of the new pump Allow for ease of maintenance Allow for proper purging		5264
7.8104.7e Sensor installation	Flow and temperature sensors will be installed in accordance with manufacturer specifications When controls are using low voltage, the low voltage and line voltage wiring will be separated Sensors, wiring, and other components will be installed in a manner that does not expose occupant/ building operations staff/property manager to hazardous conditions Sensors, wiring, and other components will be installed in a manner that does not pose an unnecessary risk to the integrity of the installation	Allow for proper operation of the demand-controlled pump Ensure long-term safety and durability of components		5265

7.8104.7f Site security	All trash and unused materials will be removed from work site daily	Protect the occupant from exposure to potential hazards		5266
7.8104.7g Commissioning	SWS 7.8104.4 Pumps will be used for commissioning Signal from hot water return temperature sensor to control unit will be verified for accuracy Signal from flow sensor to control unit will be verified for accuracy Proper control response to sensor signals will be verified Operator/owner manual will be updated or completed with site-specific data	Verify sensors and control function as designed Allow for long-term maintenance or monitoring of system		5267
7.8104.7h Education	Operator/owner manual will be provided Site staff will be educated Manual and education will include: • Purpose of control system • How to identify expected control modes • How to identify system or component failure modes • Which failures to fix • Which failures to have a plumber fix • Which failures require a different specialist • Contact information for controls installer/manufacturer	Ensure safe, efficient, reliable, and long-term operation of demand-controlled pump		5268

7.8104.8 Domestic Hot Water Expansion Tank (Potable Water)

Topic: Water Heating

Subtopic: Distribution

Desired Outcome: Provide for adequate expansion of domestic hot water as it is heated to prevent damage to piping and equipment

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8104.8a Adequate air pressure of existing air tank	Unit will be hydraulically isolated and removed from piping and drain tank Cap will be removed on bottom of tank Pressure will be checked using a tire pressure gauge	Ensure that expansion tank is properly charged and operating		5269

	Pressure will be closely matched to incoming water pressure			
7.8104.8b Proper sizing of new expansion tank	Collect necessary information to determine expansion tank size, including: • Operating water pressure of water heater (a pressure gauge may need to be installed to verify) • Water heater and tank volume • Operating water temperature • Relieve valve pressure setting • Value of incoming street water pressure	Ensure that the newly installed expansion tank will be properly sized for the system		5270
7.8104.8c Precharge air pressure in new expansion tank	Using a tire pressure gauge and a tire pump to adjust as necessary, pressure in potable water expansion tank will be set to match the incoming street water pressure	Set correct air pressure for proper operation of tank		5271
7.8104.8d New installation location of expansion tank	Expansion tank shall be installed in accordance with the manufacturer's installation instructions The expansion tank will be located on the cold water inlet to the water heater The expansion tank should be located between the water heating equipment and the required shut off	Ensure correct location of tank		5272

7.8801.1 Replacement and Maintenance

Topic: Baseload—Special Considerations

Subtopic: Elevators

Desired Outcome: Proper operation of elevator

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

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8801.1a Inspection	Inspection will be performed by a licensed elevator professional	Ensure occupant safety		5273
7.8801.1b Energy efficiency	Evaluation will be performed by a licensed elevator professional in	Optimize energy performance		5274

	conjunction with energy efficiency professionals Elevator room heating, ventilation, and air conditioning equipment will be installed with energy efficient components and proper controls			
7.8801.1c Installation and maintenance	Any work will be performed to comply with ASME A17.1, ICC A117.1, and ANSI NFPA 70 Article 620	Ensure occupant safety Ensure proper installation		5275

7.8802.1 Motor and Control Replacement

Topic: Baseload—Special Considerations

Subtopic: Spas, Hot Tubs, Saunas

Desired Outcome: Peak energy demand decreased

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

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8802.1a Assessment	Pool service professional will determine specifications for motor and controls Electric energy rate will be assessed	Determine need for motor replacement Ensure cost savings		5276
7.8802.1b Selection	Motor will be physically compatible with frame size Motor will be electrically compatible with voltages and phases Motor will be UL listed for pool, spa, or hot tub use Motor will meet efficiency standards of APSP-15 Motor will be at least 2-speed If controls are outdoors or near water, they will be suitable for use in a wet location	Ensure proper equipment operation Reduce peak energy demand Ensure occupant safety		5277
7.8802.1c Installation	Installation will be performed by qualified personnel Pump will be de-energized before beginning work Appropriate lockout procedures will be followed in accordance with OSHA 1910 Subpart S and ANSI/NFPA 70E Motor and controls will be installed in accordance with	Ensure worker safety Ensure occupant safety Optimize motor and control performance		5278

	ANSI/NFPA 70 Article 680 and manufacturer specifications			
7.8802.1d Decommissioning	If operational, motor will be stored for temporary backup use and labeled as such If nonoperational, motor will be disposed of in accordance with local ordinances or manufacturer specifications	Use resources efficiently Protect the environment		5279
7.8802.1e Staff education	Building operations staff will be provided with warranty information, operation manuals, and installer contact information	Educate building operations staff about operation and maintenance of equipment Ensure continued savings		5280

Appendices

Referenced Standards

The following lists the codes, standards, and other technical publications that support the standard work specifications for single-family home energy upgrades and can be used in two ways:

1. Starting with a publication, a reader can identify which specification(s) that publication supports.
2. Starting with a specification, a reader can identify which publication(s) support that specification.

List of Acronyms

ACRONYM	NAME
ACCA	Air Conditioning Contractors of America
ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASTM	American Society for Testing and Materials
BPI	Building Performance Institute
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
IBC	International Building Code
IECC	International Energy Conservation Code
IFGC	International Fuel Gas Code
IMC	International Mechanical Code
IRC	International Residential Code
NAECA	National Appliance Energy Conservation Act
OSHA	U.S. Occupational Safety and Health Administration
SPFA	Spray Polyurethane Foam Alliance
FTC	Federal Trade Commission
NYCDH	New York City Department of Health
ADC	Air Diffusion Council
FDA	U.S. Food and Drug Administrations
NIOSH	National Institute for Occupational Safety and Health

SMACNA	Sheet Metal and Air Conditioning Contracts National Association

Publications Referenced in the Standard Work Specifications

STANDARD REFERENCE	TITLE	SPECIFICATION
2012 IRC	International Residential Code for One-and Two-Family Dwellings	See IRC tables in Appendix C
Air Diffusion Council	Flex Duct Standard	3.1601.1j, 3.1601.2b, 4.1601.1b, 4.1601.1c, 4.1601.1d, 4.1601.1f, 4.1601.1g, 4.1601.1h, 4.1601.1j
ANSI Z21.1	Household Cooking Gas Appliances	2.0201.2d
ANSI Z21.10.1	Gas Water Heaters Volume I, Storage Water Heaters With Input Ratings Of 75,000 Btu Per Hour Or Less	2.0201.1g
ANSI Z21.11.2	Gas-fired room heaters Volume II, unvented room heaters	2.0202.1a, 2.0401.1e
ANSI Z21.74	Gas-Fired Central Furnaces	5.3003.2h
ANSI Z223.1	National Fuel Gas Code	2.0201.1f, 2.0203.1a, 2.0203.1b, 2.0203.2b, 2.0203.2c, 2.0203.2d, 5.3003.7d, 6.6003.2i, 6.6003.3j, 6.6003.4k, 6.6003.5c, 7.8102.2j, 7.8102.3i, 7.8102.3l, 7.8103.2c
ANSI/ACCA D	Residential Duct Systems	4.1601.1c, 5.3001.2a, 6.6202.2c
ANSI/ACCA J	Residential Load Calculation	5.3001.1a, 5.3101.1a, 5.3101.2a
ANSI/ACCA S	Residential Equipment Selection	5.3001.1b, 5.3101.1b
ANSI/ACCA Standard 12 QH-2011	Existing Home Evaluation and Performance Improvement	2.0201.1a, 2.0201.1i
ANSI/ACCA Standard 4 QM-2007	Maintenance for Residential HVAC Systems	5.3104.2a, 5.3104.2b
ANSI/ACCA Standard 5 QI-2010	HVAC Quality Installation Specification	5.3003.3a, 5.3003.6a, 6.6003.1h, 6.6003.2g, 6.6201.1c, 6.6202.2j
ANSI/ACCA T	Air Distribution Basics	5.3001.2b
ANSI/ASHRAE 111-2008	Measurement, Testing, Adjusting and Balancing of Building HVAC Systems	6.6003.1h, 6.6003.2g
ANSI/ASHRAE 52.2	Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size	6.6102.3f, 6.6103.1f
ANSI/ASHRAE 62.2	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings	2.0401.1e, 5.3003.7i, 5.3104.3q, 6.6005.1a, 6.6005.1e, 6.6005.2b, 6.6005.2d, 6.6102.1f, 6.6102.3f, 6.6103.1f, 6.6201.1a, 6.6201.1b, 6.6201.1c, 6.6288.1a, 6.6288.1b, 6.9901.1

ASHRAE Handbook	Fundamentals	6.6203.1b
ASTM C522	Standard Test Method for Airflow Resistance of Acoustical Materials	4.1103.1a, 4.1103.2c
ASTM C665-06	Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing	4.1402.3b
ASTM D703	Standard Specification for Polystyrene Molding and Extrusion Materials	2.0403.1c, 2.0403.2c
ASTM E2178	Standard Test Method for Air Permeance of Building Materials	4.1103.1a, 4.1103.2c
ASTM E283	Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen	4.1103.1a, 4.1103.2c
BPI 102	Standard for Air Resistance of Thermal Insulation Used in Retrofit Cavity Applications—Material Specification	4.1005.6a, 4.1103.1a, 4.1103.2c
BPI 104	Envelope Professional	4.1004.1b, 4.1005.5b, 4.1005.6a, 4.1101.1b, 4.1103.1a, 4.1103.2c, 6.6102.3a
BPI-1100-T-2012	Home Energy Auditing Standard	2.0100.1e, 2.0201.1a, 2.0201.1b, 2.0201.1c, 2.0201.1d, 2.0201.1g, 2.0201.1h, 2.0201.1i, 2.0201.2d, 2.0201.2e, 2.0201.2f, 2.0203.3a, 2.0301.1 (all), 2.0301.2 (all), 5.3003.2d, 5.3003.2h, 5.3104.2f, 7.8102.3k, 7.8103.2d
Canadian General Standards Board	Section 51.71	2.0299.1 (all)
DE-FC26-00NT40998 (2005)	A Field Study Comparison of the Energy and Moisture Performance Characteristics of Ventilated Versus Sealed Crawl Spaces in the South	2.0404.3c
DOE WPN 11-06	DOE Weatherization Program Notice	2.0100.1o, 2.0100.1p. 4.1101.2a, 4.1101.1a
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FDA Consumer Health Website	Are you storing food safely?	7.8001.2a

Federal Trade Commission	16 CFR Part 460	4.1003.4d, 4.1003.5b, 4.1003.6b, 4.1005.4d
IECC	Section C301	4.1402.1b, 4.1402.2a, 4.1402.3g
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IFGC	International Fuel Gas Code	2.0203.2b, 7.8103.2f
IMC	International Mechanical Code	6.6003.5a, 6.6005.1a, 6.6102.1e, 6.6003.5a
International Building Code	Section 1203.3.2	3.1402.2a
Minnesota Energy Code	Section 7672.0900	2.0299.1 (all)
NAECA	National Appliance Energy Conservation Act	2.0404.1a, 7.8001.1a, 7.8002.1a, 7.8004.1a, 7.8004.2a
New York City Department of Health	Guidelines on Assessments and Remediation of Fungi in Indoor Environments	2.0111.2c
NFPA 211	Standard for Chimneys, Fireplaces, Vents and Solid Fuel-Burning Appliances	2.0203.2b
NFPA 31	Standard for the Installation of Oil-Burning Equipment	5.3003.2 (all), 5.3003.7d, 7.8102.2j, 7.8102.3l, 7.8103.2f, 7.8103.2g,
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NFPA 58	Liquefied Petroleum Gas Code	5.3003.7d, 7.8102.3l, 7.8103.2f
NFPA 70	National Electrical Code®	2.0111.2b, 2.0601.1c, 2.0601.1d, 4.1001.2c, 5.3003.4d, 6.6003.2b, 6.6003.4b, 7.8003.1b, 7.8102.2j, 7.8102.3l, 7.8103.1a, 7.8103.2a, 7.8103.2g
NFPA 70A	National Electrical Code® Requirements for One- and Two-Family Dwellings	2.0100.1d, 7.8001.1b
NFPA 70E	Standard for Electrical Safety in the Workplace®	2.0100.1d
NFPA 90A/B	Standard for the Installation of Air-Conditioning and Ventilating Systems / Standard for the Installation of Warm Air Heating and Air-Conditioning Systems	3.1602.3a, 6.6102.1e
NIOSH	Recommended Exposure Limit for Carbon Monoxide	2.0100.1e, 2.0105.1b, 2.0201.1a
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R806.3	4.1088.1d
R1003.18	4.1001.3b

Publications Supporting Each Specification

SPECIFICATION	STANDARD REFERENCE	TITLE
2.0100.1d	NFPA 70A	National Electrical Code® Requirements for One- and Two-Family Dwellings
2.0100.1d	NFPA 70E	Standard for Electrical Safety in the Workplace®
2.0100.1e	ANSI/ASHRAE 62.2	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
2.0100.1e	BPI-1100-T-2012	Home Energy Auditing Standard
2.0100.1e	Environmental Protection Agency	Healthy Indoor Environment Protocols for Home Energy Upgrades
2.0100.1e	NIOSH	Recommended Exposure Limit for Carbon Monoxide
2.0100.1f	OSHA	General
2.0100.1o	DOE WPN 11-06	DOE Weatherization Program Notice
2.0100.1p	DOE WPN 11-06	DOE Weatherization Program Notice
2.0103.2a	OSHA	10-hour and 30-hour education
2.0103.2c	ANSI/ACCA Manual J	Residential Load Calculation
2.0103.2c	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
2.0103.2c	BPI	General

2.0103.2d	EPA Indoor airPLUS	Construction Specifications Section 1.1
2.0104.1b	OSHA	General
2.0104.2a	OSHA 1910	Occupational Safety and Health Standards, Section 134
2.0104.2a	OSHA 1926	Safety and Health Regulations for Construction, Section 103
2.0104.2b	OSHA 1926	Safety and Health Regulations for Construction, Section 1101
2.0104.2c	OSHA 1910	Occupational Safety and Health Standards, Subpart Z
2.0104.2c	OSHA 1910	Occupational Safety and Health Standards, Section 134
2.0104.2c	OSHA 1926	Safety and Health Regulations for Construction, Section 103
2.0104.2d	EPA	40 CFR Part 745
2.0104.2d	EPA	40 CFR Part 745
2.0105.1b	NIOSH	Recommended Exposure Limit for Carbon Monoxide
2.0107.2a	NFPA 70	National Electrical Code® Requirements for One- and Two-Family Dwellings
2.0107.2a	NFPA 70E	Standard for Electrical Safety in the Workplace®
2.0107.2a	OSHA	General
2.0111.2a	2012 IRC	General
2.0111.2b	NFPA 70	National Electrical Code®
2.0111.2c	New York City Department of Health	Guidelines on Assessments and Remediation of Fungi in Indoor Environments
2.0111.2d	2012 IRC	General
2.0111.2e	2012 IRC	General
2.0111.2f	2012 IRC	General
2.0111.2g	2012 IRC	General
2.0111.3a	2012 IRC	R408.5
2.0201.1a	ANSI/ACCA Standard 12 QH-2011	Existing Home Evaluation and Performance Improvement
2.0201.1a	BPI-1100-T-2012	Home Energy Auditing Standard
2.0201.1a	NIOSH	Recommended Exposure Limit for Carbon Monoxide
2.0201.1b	2012 IRC	G2417.1.2
2.0201.1b	BPI-1100-T-2012	Home Energy Auditing Standard
2.0201.1c	BPI-1100-T-2012	Home Energy Auditing Standard
2.0201.1d	BPI-1100-T-2012	Home Energy Auditing Standard
2.0201.1f	ANSI Z223.1	National Fuel Gas Code
2.0201.1f	NFPA 54	National Fuel Gas Code
2.0201.1g	ANSI Z21.10.1	Gas Water Heaters Volume I, Storage Water Heaters With Input Ratings Of 75,000 Btu Per Hour Or Less
2.0201.1g	BPI-1100-T-2012	Home Energy Auditing Standard
2.0201.1h	BPI-1100-T-2012	Home Energy Auditing Standard

2.0201.1i	ANSI/ACCA Standard 12 QH-2011	Existing Home Evaluation and Performance Improvement
2.0201.1i	BPI-1100-T-2012	Home Energy Auditing Standard
2.0201.2a	2012 IRC	Chapter 24
2.0201.2a	2012 IRC	General
2.0201.2b	2012 IRC	G2427.8
2.0201.2c	ANSI/ASHRAE 62.2	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
2.0201.2d	ANSI Z21.1	Household Cooking Gas Appliances
2.0201.2d	BPI-1100-T-2012	Home Energy Auditing Standard
2.0201.2e	BPI-1100-T-2012	Home Energy Auditing Standard
2.0201.2f	BPI-1100-T-2012	Home Energy Auditing Standard
2.0202.1a	ANSI Z21.11.2	Gas-Fired Room Heaters Volume II, Unvented Room Heaters
2.0202.1a	Environmental Protection Agency	Healthy Indoor Environment Protocols for Home Energy Upgrades
2.0203.1a	2012 IRC	G2407.5.1
2.0203.1b	2012 IRC	G2407
2.0203.2b	2012 IRC	G2425
2.0203.2b	2012 IRC	General
2.0203.2b	ANSI Z223.1	National Fuel Gas Code
2.0203.2b	IFGC	International Fuel Gas Code
2.0203.2b	NFPA 211	Standard for Chimneys, Fireplaces, Vents and Solid Fuel-Burning Appliances
2.0203.2b	NFPA 54	National Fuel Gas Code
2.0203.2c	ANSI Z223.1	National Fuel Gas Code
2.0203.2c	NFPA 54	National Fuel Gas Code
2.0203.2d	2012 IRC	G2407.5.1
2.0203.2e	2012 IRC	G2407
2.0203.2f	ANSI/ASHRAE 62.2	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
2.0203.2f	Environmental Protection Agency	Healthy Indoor Environment Protocols for Home Energy Upgrades
2.0203.2g	Environmental Protection Agency	Healthy Indoor Environment Protocols for Home Energy Upgrades
2.0203.3a	BPI-1100-T-2012	Home Energy Auditing Standard
2.0203.3d	ANSI/ASHRAE 62.2	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
2.0203.3d	Environmental Protection Agency	Healthy Indoor Environment Protocols for Home Energy Upgrades
2.0203.7a	IFGC	International Fuel Gas Code
2.0203.7a	NFPA 31	Standard for the Installation of Oil-Burning Equipment
2.0203.7a	NFPA 54/ANSI/AGA Z223.1	National Fuel Gas Code
2.0203.7b	ASTM E1998 - 02(2007)	Standard Guide for Assessing Depressurization-Induced Backdrafting

		and Spillage from Vented Combustion Appliances
2.0203.7b	BPI-1100-T-2012	Home Energy Auditing Standard
2.0203.7c	ANSI/ACCA 4 -- 2007	Maintenance of Residential HVAC Systems in One- and Two-Family Dwellings Less Than Three Stories, 2007
2.0203.7c	NFPA 54/ANSI/AGA Z223.1	National Fuel Gas Code
2.0204.2b	ASTM E1186 - 03(2009)	03(2009) Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems
2.0204.2c	OSHA 1910	Occupational Safety and Health Standards
2.0204.2c	OSHA 1926	Safety and Health Regulations for Construction
2.0204.2d	Green Seal Standard GS-36	Adhesives for Commercial Use
2.0204.2d	GREENGUARD Children and Schools Certification Program	General
2.0205.1a	ANSI/ACCA 5 - 2010 QI	HVAC Quality Installation Specification
2.0205.1a	IFGC	International Fuel Gas Code
2.0205.1a	NFPA 31	Standard for the Installation of Oil-Burning Equipment
2.0205.1a	NFPA 54/ANSI/AGA Z223.1	National Fuel Gas Code
2.0205.1b	IFGC	International Fuel Gas Code
2.0205.1b	NFPA 31	Standard for the Installation of Oil-Burning Equipment
2.0205.1b	NFPA 54/ANSI/AGA Z223.1	National Fuel Gas Code
2.0205.1c	IFGC	International Fuel Gas Code
2.0205.1c	NFPA 31	Standard for the Installation of Oil-Burning Equipment
2.0205.1c	NFPA 54/ANSI/AGA Z223.1	National Fuel Gas Code
2.0299.1 (all)	Canadian General Standards Board	Section 51.71
2.0299.1 (all)	Minnesota Energy Code	Section 7672.0900
2.0301.1 (all)	BPI-1100-T-2012	Home Energy Auditing Standard
2.0301.1a	2012 IRC	General
2.0301.1a	2012 IRC	R314
2.0301.1b	2012 IRC	General
2.0301.1b	2012 IRC	R314
2.0301.2 (all)	BPI-1100-T-2012	Home Energy Auditing Standard
2.0301.2a	2012 IRC	R315
2.0301.2a	ANSI/ASHRAE 62.2	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
2.0301.2b	ANSI/ASHRAE 62.2	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
2.0401.1b	2012 IRC	R408.1
2.0401.1b	2012 IRC	R408.2
2.0401.1b	2012 IRC	R408.3
2.0401.1b	2012 IRC	R702.7.2

2.0401.1e	2012 IRC	M1502
2.0401.1e	2012 IRC	M1503
2.0401.1e	2012 IRC	M1504
2.0401.1e	2012 IRC	M1505
2.0401.1e	2012 IRC	M1506
2.0401.1e	2012 IRC	M1507
2.0401.1e	ANSI Z21.11.2	Gas-Fired Room Heaters Volume II, Unvented Room Heaters
2.0401.1e	ANSI/ASHRAE 62.2	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
2.0401.1f	2012 IRC	R405
2.0401.1f	2012 IRC	R406
2.0401.1f	2012 IRC	R703.8
2.0401.1f	Environmental Protection Agency	EPA Indoor airPLUS
2.0401.2a	2012 IRC	General
2.0401.2a	2012 IRC	R408.2
2.0402.1c	2012 IRC	R405
2.0402.1c	2012 IRC	R406
2.0403.1c	ASTM D703	Standard Specification for Polystyrene Molding and Extrusion Materials
2.0403.2c	ASTM D703	Standard Specification for Polystyrene Molding and Extrusion Materials
2.0403.3a	2012 IRC	R408.3
2.0404.1a	ENERGY STAR	General
2.0404.1a	NAECA	National Appliance Energy Conservation Act
2.0404.1b	2012 IRC	G2439.1
2.0404.1b	2012 IRC	M1502.2
2.0404.1b	2012 IRC	P3303.1.2
2.0404.2a	2012 IRC	G2407.5.1
2.0404.2c	Wood Handbook	Wood as an Engineering Material
2.0404.3b	ENERGY STAR	General
2.0404.3c	DE-FC26-00NT40998 (2005, Advanced Energy)	A Field Study Comparison of the Energy and Moisture Performance Characteristics of Ventilated Versus Sealed Crawl Spaces in the South
2.0404.4a	ENERGY STAR	General
2.0501.1a	Environmental Protection Agency	Healthy Indoor Environment Protocols for Home Energy Upgrades
2.0501.2a	Environmental Protection Agency	Healthy Indoor Environment Protocols for Home Energy Upgrades
2.0502.1a	EPA - Healthy Indoor Environment Protocols for Home Energy Retrofits	Single Family Residential
2.0601.1c	NFPA 70	National Electrical Code®
2.0601.1d	NFPA 70	National Electrical Code®
2.0701.1a	2012 IRC	AF103.4.10
2.0701.1a	2012 IRC	M1305.1.4
2.0701.1a	2012 IRC	N1102.2.4

2.0701.1a	2012 IRC	R408.4
2.0702.2a	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
2.0702.2b	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
2.0702.2c	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
2.0702.2d	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
2.0702.2e	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
2.0702.2i	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
2.0702.3a	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
2.0702.3b	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
2.0702.3c	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
2.0702.3d	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
2.0702.3e	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
2.0702.3g	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
2.0702.4a	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
2.0702.4b	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
2.0702.4c	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
2.0702.4d	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings

2.0702.4e	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
2.0702.4g	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
2.0702.4i	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
3.1001.2b	2012 IRC	N1102.4.1.2
3.1001.2c	2012 IRC	R302.9
3.1001.3b	2012 IRC	N1102.4.1.2
3.1001.5	ASTM E1186 - 03(2009)	03(2009) Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems
3.1001.5c	ASTM C834 - 10	Standard Specification for Latex Sealants
3.1001.5c	Green Seal Standard GS-36	Adhesives for Commercial Use
3.1001.5c	GREENGUARD Children and Schools Certification Program	General
3.1001.5d	ASTM E136 - 09b	Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C
3.1001.6c	Green Seal Standard GS-36	Adhesives for Commercial Use
3.1001.6c	GREENGUARD Children and Schools Certification Program	General
3.1001.7c	Green Seal Standard GS-36	Adhesives for Commercial Use
3.1001.7c	GREENGUARD Children and Schools Certification Program	General
3.1001.8b	ASTM E1186 - 03(2009)	03(2009) Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems
3.1001.8b	IBC - 2009	International Building Code
3.1001.8b	IRC	International Residential Code
3.1001.8b	NFPA	General
3.1001.8e	ASTM C1015 - 06	Standard Practice for Installation of Cellulosic and Mineral Fiber Loose Fill Thermal Insulation
3.1001.8f	Federal Trade Commission	16 CFR Part 460, Section 460.17
3.1001.9d	Green Seal Standard GS-36	Adhesives for Commercial Use
3.1001.9d	GREENGUARD Children and Schools Certification Program	General
3.1001.9e	ASTM E1186 - 03(2009)	03(2009) Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems
3.1001.9f	IECC - 2009	International Energy Conservation Code, Section 402.2.3
3.1001.9h	ASTM E1186 - 03(2009)	03(2009) Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems
3.1001.9j	Federal Trade Commission	16 CFR Part 460, Section 460.17

3.1002.1b	2012 IRC	N1102.4.1.2
3.1003.5b	2012 IRC	N1102.4.1.2
3.1003.5b	2012 IRC	R402.4.1.2
3.1005.2d	Green Seal Standard GS-36	Adhesives for Commercial Use
3.1005.2d	GREENGUARD Children and Schools Certification Program	General
3.1005.2e	ASTM E1186 - 03(2009)	03(2009) Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems
3.1005.2f	ASTM C1015 - 06	Standard Practice for Installation of Cellulosic and Mineral Fiber Loose Fill Thermal Insulation
3.1005.2g	Federal Trade Commission	16 CFR Part 460, Section 460.17
3.1005.3c	ASTM C1015 - 06	Standard Practice for Installation of Cellulosic and Mineral Fiber Loose Fill Thermal Insulation
3.1005.3c	ASTM E1186 - 03(2009)	03(2009) Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems
3.1005.3e	ASTM C834 - 10	Standard Specification for Latex Sealants
3.1005.3f	Green Seal Standard GS-36	Adhesives for Commercial Use
3.1005.3f	GREENGUARD Children and Schools Certification Program	General
3.1005.3g	ASTM E1186 - 03(2009)	03(2009) Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems
3.1102.1c	Green Seal Standard GS-36	Adhesives for Commercial Use
3.1102.1c	GREENGUARD Children and Schools Certification Program	General
3.1102.1d	ASTM E136 - 09b	Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C
3.1201.4b	OSHA	General
3.1201.7f	Green Seal Standard GS-36	Adhesives for Commercial Use
3.1201.7f	GREENGUARD Children and Schools Certification Program	General
3.1201.7i	ASTM E1186 - 03(2009)	03(2009) Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems
3.1201.7i	ASTM E783-02	Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors
3.1201.8e	Green Seal Standard GS-36	Adhesives for Commercial Use
3.1201.8e	GREENGUARD Children and Schools Certification Program	General
3.1201.8h	ASTM E1186 - 03(2009)	03(2009) Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems

3.1201.8h	ASTM E783-02	Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors
3.1203.4a	AMAA/WDMA/CSA/101/IS2/A440	North American Fenestration Standard/Specification for windows, doors and skylights
3.1203.4a	National Fenestration Rating Council (NFRC)	General
3.1203.4e	Green Seal Standard GS-36	Adhesives for Commercial Use
3.1203.4e	GREENGUARD Children and Schools Certification Program	General
3.1203.4g	ASTM E1105-00	Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform or Cyclic Static Air Pressure Difference
3.1203.4g	ASTM E783-02	Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors
3.1203.5a	CPSC 16 CFR Part 1201	General
3.1203.5a	National Fenestration Rating Council (NFRC)	General
3.1203.5d	Green Seal Standard GS-36	Adhesives for Commercial Use
3.1203.5d	GREENGUARD Children and Schools Certification Program	General
3.1203.5f	ASTM E1105-00	Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform or Cyclic Static Air Pressure Difference
3.1203.5f	ASTM E1186 - 03(2009)	03(2009) Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems
3.1203.5f	ASTM E783-02	Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors
3.1402.2a	International Building Code	Section 1203.3.2
3.1402.5a	IECC	Section 402.2.3
3.1402.5b	2012 IRC	Chapter 4
3.1402.5b	2012 IRC	M1305.1.4
3.1402.5b	2012 IRC	R408.4
3.1403.1a	ANSI-AARST	Protocol for Conducting Radon and Radon Decay Product Measurements in Multifamily Buildings
3.1403.1b	ASTM E1186 - 03(2009)	03(2009) Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems
3.1403.1c	OSHA 1910	Occupational Safety and Health Standards

3.1403.1c	OSHA 1926	Safety and Health Regulations for Construction
3.1403.1d	Green Seal Standard GS-36	Adhesives for Commercial Use
3.1403.1d	GREENGUARD Children and Schools Certification Program	General
3.1501.1b	2012 IRC	N1103.2.2
3.1501.1f	ANSI/ASHRAE 62.2	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
3.1501.2a	ASTM C1193 - 09	Standard Guide for Use of Joint Sealants
3.1501.2c	ASTM C1193 - 09	Standard Guide for Use of Joint Sealants
3.1501.2e	CPSC 16 CFR 1201	General
3.1502.1b	ASTM E1186 - 03(2009)	03(2009) Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems
3.1502.1c	OSHA 1910	Occupational Safety and Health Standards
3.1502.1c	OSHA 1926	Safety and Health Regulations for Construction
3.1502.1d	Green Seal Standard GS-36	Adhesives for Commercial Use
3.1502.1d	GREENGUARD Children and Schools Certification Program	General
3.1502.2f	ANSI/ACCA 5 - 2010 QI	HVAC Quality Installation Specification
3.1502.2f	ANSI/ASHRAE Standard 111	Measurement, Testing, Adjusting and Balancing of Building HVAC Systems
3.1601.1 (all)	SMACNA	Duct Construction Standards
3.1601.1a	2012 IRC	Chapter 16
3.1601.1a	2012 IRC	N1103.2
3.1601.1b	2012 IRC	Chapter 16
3.1601.1b	2012 IRC	M1601.1.1
3.1601.1b	2012 IRC	N1103.2
3.1601.1c	2012 IRC	Chapter 16
3.1601.1c	2012 IRC	N1103.2
3.1601.1d	2012 IRC	Chapter 16
3.1601.1d	2012 IRC	N1103.2
3.1601.1e	2012 IRC	M1601.4.1
3.1601.1f	2012 IRC	M1601.4.1
3.1601.1g	2012 IRC	Chapter 16
3.1601.1g	2012 IRC	N1103.2
3.1601.1h	2012 IRC	Chapter 16
3.1601.1h	2012 IRC	N1103.2
3.1601.1i	2012 IRC	Chapter 16
3.1601.1i	2012 IRC	N1103.2
3.1601.1j	2012 IRC	N1103.2
3.1601.1j	Air Diffusion Council	Flex Duct Standard
3.1601.1l	2012 IRC	Chapter 16
3.1601.2b	Air Diffusion Council	Flex Duct Standard
3.1601.3a	2012 IRC	Chapter 16
3.1601.3a	2012 IRC	M1601.4.3

3.1601.6	SMACNA	Duct Construction Standard
3.1601.6	SMACNA	Duct Construction Standard
3.1601.6	SMACNA	Duct Construction Standard
3.1601.6	UL 181B	Closure Systems for Use With Flexible Air Ducts and Air Connectors
3.1601.6	SMACNA	Duct Construction Standard
3.1601.6	SMACNA	Duct Construction Standard
3.1601.6	SMACNA	Duct Construction Standard
3.1601.6	SMACNA	Duct Construction Standard
3.1601.6	SMACNA	Duct Construction Standard
3.1601.6	SMACNA	Duct Construction Standard
3.1601.6	NAIMA	Fibrous Glass Duct Construction Standards
3.1601.7	NAIMA	Fibrous Glass Duct Construction Standards
3.1601.7	SMACNA	Duct Construction Standard
3.1601.8a	SMACNA	Duct Construction Standard
3.1601.8b	SMACNA	Duct Construction Standard
3.1601.8c	SMACNA	Duct Construction Standard
3.1601.8c	UL 181B	Closure Systems for Use With Flexible Air Ducts and Air Connectors
3.1601.8d	SMACNA	Duct Construction Standard
3.1601.8e	NAIMA	Fibrous Glass Duct Construction Standards
3.1601.8e	SMACNA	Duct Construction Standard
3.1601.8i	SMACNA	Duct Construction Standard
3.1601.8j	SMACNA	Duct Construction Standard
3.1601.8k	SMACNA	Duct Construction Standard
3.1601.8l	SMACNA	Duct Construction Standard
3.1601.9a	NAIMA	Fibrous Glass Duct Construction Standards
3.1601.9a	SMACNA	Duct Construction Standard
3.1601.9a	SMACNA	Duct Construction Standard
3.1601.9b	SMACNA	Duct Construction Standard
3.1601.9c	SMACNA	Duct Construction Standard
3.1602.1 (all)	2012 IRC	Chapter 16
3.1602.15b	OSHA 1910	Occupational Safety and Health Standards
3.1602.15b	OSHA 1929	Lead in Construction
3.1602.15c	ASTM E1186 - 03(2009)	03(2009) Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems
3.1602.15g	UL 181	Factory-Made Air Ducts and Air Connectors
3.1602.15j	ASTM E1998 - 02(2007)	Standard Guide for Assessing Depressurization-Induced Backdrafting and Spillage from Vented Combustion Appliances
3.1602.16	SMACNA	Duct Construction Standard

3.1602.16	SMACNA	Duct Construction Standard
3.1602.16	SMACNA	Duct Construction Standard
3.1602.17	SMACNA	Duct Construction Standard
3.1602.17	SMACNA	Duct Construction Standard
3.1602.17	SMACNA	Duct Construction Standard
3.1602.18	ASTM C834 - 10	Standard Specification for Latex Sealants
3.1602.18	SMACNA	Duct Construction Standard
3.1602.19	NFPA 90A	Standard for the Installation of Air-Conditioning and Ventilating Systems
3.1602.19	NFPA 90B	Standard for the Installation of Warm Air Heating and Air-Conditioning Systems
3.1602.20	NFPA 90A	Standard for the Installation of Air-Conditioning and Ventilating Systems
3.1602.20	NFPA 90B	Standard for the Installation of Warm Air Heating and Air-Conditioning Systems
3.1602.20	SMACNA	Duct Construction Standard
3.1602.20	UL 181B	Closure Systems for Use With Flexible Air Ducts and Air Connectors
3.1602.22a	SMACNA	Duct Construction Standard
3.1602.22b	SMACNA	Duct Construction Standard
3.1602.22c	SMACNA	Duct Construction Standard
3.1602.22c	UL 181	Factory-Made Air Ducts and Air Connectors
3.1602.23a	NFPA 90A	Standard for the Installation of Air-Conditioning and Ventilating Systems
3.1602.23a	NFPA 90B	Standard for the Installation of Warm Air Heating and Air-Conditioning Systems
3.1602.23a	SMACNA	Duct Construction Standard
3.1602.23a	UL 181M	General
3.1602.2a	2012 IRC	M1601.3
3.1602.2a	2012 IRC	R316.1
3.1602.2a	2012 IRC	R316.2
3.1602.2a	2012 IRC	R316.3
3.1602.2a	2012 IRC	R316.4
3.1602.2a	2012 IRC	R316.5
3.1602.2a	2012 IRC	R316.6
3.1602.2a	2012 IRC	R316.7
3.1602.3a	NFPA 90A/B	Standard for the Installation of Air-Conditioning and Ventilating Systems / Standard for the Installation of Warm Air Heating and Air-Conditioning Systems
3.1602.4a	2012 IRC	N1102.4.1.1
3.1602.4a	2012 IRC	R302.9
3.1602.4b	2012 IRC	N1103.2.2
3.1602.5c	2012 IRC	N1102.4.1.1
3.1602.5c	2012 IRC	R302.9
3.1602.6b	2012 IRC	N1102.4.1.1
3.1602.6b	2012 IRC	R302.9
3.1801.2e	Green Seal Standard GS-36	Adhesives for Commercial Use

3.1801.2e	GREENGUARD Children and Schools Certification Program	General
3.1801.2i	ASTM E1186 - 03(2009)	03(2009) Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems
3.1802.1c	Green Seal Standard GS-36	Adhesives for Commercial Use
3.1802.1c	GREENGUARD Children and Schools Certification Program	General
3.1802.2h	ASTM E1186 - 03(2009)	03(2009) Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems
3.1802.2i	ASTM E84	Standard Test Method for Surface Burning Characteristics of Building Materials
3.1802.2i	UL 723	Test for Surface Burning Characteristics of Building Materials
3.1901.1b	ASTM E1186 - 03(2009)	03(2009) Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems
3.1901.1c	OSHA 1910	Occupational Safety and Health Standards
3.1901.1c	OSHA 1926	Safety and Health Regulations for Construction
3.1901.1d	Green Seal Standard GS-36	Adhesives for Commercial Use
3.1901.1d	GREENGUARD Children and Schools Certification Program	General
3.1901.3b	ASTM E1186 - 03(2009)	03(2009) Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems
3.1901.3c	OSHA 1910	Occupational Safety and Health Standards
3.1901.3c	OSHA 1926	Safety and Health Regulations for Construction
3.1901.3d	Green Seal Standard GS-36	Adhesives for Commercial Use
3.1901.3d	GREENGUARD Children and Schools Certification Program	General
3.1901.4c	ASTM E1186 - 03(2009)	03(2009) Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems
3.1901.4c	OSHA	Lock Out Standard
3.1901.4d	OSHA 1910	Occupational Safety and Health Standards
3.1901.4d	OSHA 1926	Safety and Health Regulations for Construction
3.1901.4e	Green Seal Standard GS-36	Adhesives for Commercial Use
3.1901.4e	GREENGUARD Children and Schools Certification Program	General
3.1901.c	OSHA 1910	Occupational Safety and Health Standards

3.1901.c	OSHA 1926	Safety and Health Regulations for Construction
3.1901.d	ASTM E1186 - 03(2009)	03(2009) Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems
3.1901.e	Green Seal Standard GS-36	Adhesives for Commercial Use
3.1901.e	GREENGUARD Children and Schools Certification Program	General
4.1001.1a	2012 IRC	E4003.2
4.1001.1a	2012 IRC	E4004.2
4.1001.1b	2012 IRC	E4004.9
4.1001.1c	2012 IRC	E4003.2
4.1001.1c	2012 IRC	E4004.9
4.1001.1d	2012 IRC	N1102.4.4
4.1001.2c	NFPA 70	National Electrical Code®
4.1001.3b	2012 IRC	M1801.3.4
4.1001.3b	2012 IRC	R1003.18
4.1001.7a	Wood Handbook	Wood as an Engineering Material
4.1001.8d	IRC	International Residential Code, Section 806.4
4.1003.12d	IRC	International Residential Code, Section 806.4
4.1003.12e	ASTM E84	Standard Test Method for Surface Burning Characteristics of Building Materials
4.1003.12e	IBC - 2009	International Building Code, Section 1405.3
4.1003.12e	IRC - 2009	International Residential Code, Section R806.4
4.1003.12e	Spray Polyurethane Foam Alliance - AY-141	Spray Polyurethane Foam and Cathedral Roofs and Cathedralized
4.1003.12e	UL 723	Test for Surface Burning Characteristics of Building Materials
4.1003.13a	ASTM E84	Standard Test Method for Surface Burning Characteristics of Building Materials
4.1003.13a	IBC - 2009	International Building Code, Section 1405.3
4.1003.13a	IRC - 2009	International Residential Code, Section R806.4
4.1003.13a	Spray Polyurethane Foam Alliance - AY-141	Spray Polyurethane Foam and Cathedral Roofs and Cathedralized
4.1003.13a	UL 723	Test for Surface Burning Characteristics of Building Materials
4.1003.13b	Federal Trade Commission	16 CFR Part 460, Section 460.17
4.1003.13c	Federal Trade Commission	16 CFR Part 460, Section 460.17
4.1003.14d	ASTM E84	Standard Test Method for Surface Burning Characteristics of Building Materials

4.1003.14d	IECC 2012	International Energy Conservation Code, Section 303.1.1.1
4.1003.14d	UL 723	Test for Surface Burning Characteristics of Building Materials
4.1003.14e	ASTM C1015 - 06	Standard Practice for Installation of Cellulosic and Mineral Fiber Loose Fill Thermal Insulation
4.1003.1a	2012 IRC	R806
4.1003.2a	2012 IRC	N1102.2.2
4.1003.2c	BPI 104	Envelope Professional
4.1003.4d	2012 IRC	N1101.16
4.1003.4d	Federal Trade Commission	16 CFR Part 460
4.1003.5a	Spray Polyurethane Foam Alliance	AY-141 Spray Polyurethane Foam and Cathedral Roofs and Cathedralized Attics
4.1003.5b	2012 IRC	N1101.16
4.1003.5b	Federal Trade Commission	16 CFR Part 460
4.1003.6a	Spray Polyurethane Foam Alliance	AY-141 Spray Polyurethane Foam and Cathedral Roofs and Cathedralized Attics
4.1003.6b	2012 IRC	N1101.16
4.1003.6b	Federal Trade Commission	16 CFR Part 460
4.1004.1b	BPI 104	Envelope Professional
4.1005.2d	2012 IRC	N1101.16
4.1005.4d	2012 IRC	N1101.16
4.1005.4d	Federal Trade Commission	16 CFR Part 460
4.1005.5b	BPI 104	Envelope Professional
4.1005.5d	2012 IRC	N1101.16
4.1005.6a	BPI 102	Standard for Air Resistance of Thermal Insulation Used in Retrofit Cavity Applications—Material Specification
4.1005.6a	BPI 104	Envelope Professional
4.1005.6c	2012 IRC	N1101.16
4.1005.7c	2012 IRC	N1101.16
4.1005.8a	IECC 2012	International Energy Conservation Code, Section 303.1.1.1
4.1005.8b	ASTM C1015 - 06	Standard Practice for Installation of Cellulosic and Mineral Fiber Loose Fill Thermal Insulation
4.1005.8c	ASTM C1015 - 06	Standard Practice for Installation of Cellulosic and Mineral Fiber Loose Fill Thermal Insulation
4.1005.8c	ASTM E84	Standard Test Method for Surface Burning Characteristics of Building Materials
4.1005.8d	Federal Trade Commission	16 CFR Part 460, Section 460.17
4.1006.1a	IECC	Section R402.2.4
4.1006.2a	IECC	Section R402.2.4
4.1088.1a	2012 IRC	N1102.4.1.1
4.1088.1a	2012 IRC	R806
4.1088.1b	2012 IRC	R806.1

4.1088.1c	2012 IRC	R806
4.1088.1d	2012 IRC	R806.3
4.1088.1e	2012 IRC	R806.1
4.1088.1e	2012 IRC	R806.2
4.1088.5a	Environmental Protection Agency	Healthy Indoor Environment Protocols for Home Energy Upgrades
4.1088.9d	Green Seal Standard GS-36	Adhesives for Commercial Use
4.1088.9d	GREENGUARD Children and Schools Certification Program	General
4.1101.1a	DOE WPN 11-06	DOE Weatherization Program Notice
4.1101.1b	BPI 104	Envelope Professional
4.1101.2a	DOE WPN 11-06	DOE Weatherization Program Notice
4.1101.2a	Environmental Protection Agency	Healthy Indoor Environment Protocols for Home Energy Upgrades
4.1101.3c	Wood Handbook	Wood as an Engineering Material
4.1103.1a	ASTM C522	Standard Test Method for Airflow Resistance of Acoustical Materials
4.1103.1a	ASTM E2178	Standard Test Method for Air Permeance of Building Materials
4.1103.1a	ASTM E283	Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
4.1103.1a	BPI 102	Standard for Air Resistance of Thermal Insulation Used in Retrofit Cavity Applications—Material Specification
4.1103.1a	BPI 104	Envelope Professional
4.1103.2c	ASTM C522	Standard Test Method for Airflow Resistance of Acoustical Materials
4.1103.2c	ASTM E2178	Standard Test Method for Air Permeance of Building Materials
4.1103.2c	ASTM E283	Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
4.1103.2c	BPI 102	Standard for Air Resistance of Thermal Insulation Used in Retrofit Cavity Applications—Material Specification
4.1103.4a	OSHA 3142-09R	Lead in Construction
4.1103.4e	Green Seal Standard GS-36	Adhesives for Commercial Use
4.1103.4e	GREENGUARD Children and Schools Certification Program	General
4.1103.4f	ASTM C522	Standard Test Method for Airflow Resistance of Acoustical Materials
4.1103.4f	ASTM E1186 - 03(2009)	03(2009) Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems

4.1103.4f	ASTM E84	Standard Test Method for Surface Burning Characteristics of Building Materials
4.1103.4f	BPI-102	Standard for Air Resistance of Thermal Insulation Used in Retrofit Cavity Applications - Material Specification
4.1103.4f	E 2178	General
4.1103.4f	E 283	General
4.1103.4f	Federal Trade Commission	16 CFR Part 460, Section 460.17
4.1103.5c	IBC - 2009	International Building Code, Section 2603.4
4.1103.5e	Green Seal Standard GS-36	Adhesives for Commercial Use
4.1103.5e	GREENGUARD Children and Schools Certification Program	General
4.1301.10b	OSHA 1910	Occupational Safety and Health Standards
4.1301.10b	OSHA 1926	Safety and Health Regulations for Construction
4.1301.10c	IBC - 2009	International Building Code, Section 2603.1
4.1301.10c	IBC - 2009	International Building Code, Section 2603.4
4.1301.10c	IBC - 2009	International Building Code, Section 2603.4.1
4.1301.10c	IBC - 2009	International Building Code, Section 2603.4.1.14
4.1301.10c	IBC - 2009	International Building Code, Section 718
4.1301.10c	NFPA 275	Standard Method of Fire Tests for the Evaluation of Thermal Barriers
4.1301.14b	OSHA 1910	Occupational Safety and Health Standards
4.1301.14b	OSHA 1926	Safety and Health Regulations for Construction
4.1301.14f	ASTM E84	Standard Test Method for Surface Burning Characteristics of Building Materials
4.1301.14f	UL 723	Test for Surface Burning Characteristics of Building Materials
4.1301.14g	ASTM E84	Standard Test Method for Surface Burning Characteristics of Building Materials
4.1301.14g	UL 723	Test for Surface Burning Characteristics of Building Materials
4.1301.15e	ASTM E84	Standard Test Method for Surface Burning Characteristics of Building Materials
4.1301.15e	UL 723	Test for Surface Burning Characteristics of Building Materials

4.1301.15f	ASTM E84	Standard Test Method for Surface Burning Characteristics of Building Materials
4.1301.15f	UL 723	Test for Surface Burning Characteristics of Building Materials
4.1301.15f	Green Seal Standard GS-36	Adhesives for Commercial Use
4.1301.15f	GREENGUARD Children and Schools Certification Program	General
4.1301.9a	Wood Handbook	Wood as an Engineering Material
4.1301.9c	2012 IRC	R316.4
4.1401.1a	Wood Handbook	Wood as an Engineering Material
4.1401.1c	2012 IRC	R316.4
4.1402.1b	IECC	Section 301
4.1402.2a	IECC	Section 301
4.1402.3b	ASTM C665-06	Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing
4.1402.3g	IECC	Section 301
4.1402.3i	2012 IRC	General
4.1601.1b	Air Diffusion Council	Flex Duct Standard
4.1601.1c	Air Diffusion Council	Flex Duct Standard
4.1601.1c	ANSI/ACCA D	Residential Duct Systems
4.1601.1d	Air Diffusion Council	Flex Duct Standard
4.1601.1e	2012 IRC	M1601.1
4.1601.1f	2012 IRC	M1601.4.1
4.1601.1f	Air Diffusion Council	Flex Duct Standard
4.1601.1g	Air Diffusion Council	Flex Duct Standard
4.1601.1h	2012 IRC	M1601.4.1
4.1601.1h	Air Diffusion Council	Flex Duct Standard
4.1601.1j	2012 IRC	M1601.4.1
4.1601.1j	Air Diffusion Council	Flex Duct Standard
4.1601.2a	SMACNA	Duct Construction Standards
4.1601.2a	SMACNA	Duct Construction Standards
4.1601.2b	2012 IRC	M1601.4.1
4.1601.2b	SMACNA	Duct Construction Standards
4.1601.2b	SMACNA	Duct Construction Standards
4.1601.2c	SMACNA	Duct Construction Standards
4.1601.2c	SMACNA	Duct Construction Standards
4.1601.2d	2012 IRC	Chapter 16
4.1601.2d	SMACNA	Duct Construction Standards
4.1601.2d	SMACNA	Duct Construction Standards
5.3001.1a	ANSI/ACCA J	Residential Load Calculation
5.3001.1b	ANSI/ACCA S	Residential Equipment Selection
5.3001.2a	ANSI/ACCA D	Residential Duct Systems
5.3001.2b	ANSI/ACCA T	Air Distribution Basics
5.3001.4d	ANSI/ACCA 5 - 2010 QI	HVAC Quality Installation Specification
5.3001.4d	ANSI/ACCA Manual J	Residential Load Calculation
5.3001.4d	ANSI/ACCA Manual N	Commercial Load Calculation for Small Commercial Buildings

5.3001.4d	ANSI/ASHRAE Standard 90.2 - 2007	Energy Efficient Design of Low-Rise Residential Buildings
5.3001.4d	ANSI/ASHRAE Standard 90.2 - 2007	Energy Efficient Design of Low-Rise Residential Buildings
5.3001.4d	ASHRAE	Fundamentals Handbook
5.3001.4d	ANSI/ASHRAE Standard 90.2 - 2007	Energy Efficient Design of Low-Rise Residential Buildings
5.3001.4d	ASHRAE	Fundamentals Handbook
5.3001.4d	ANSI/ACCA 5 - 2010 QI	HVAC Quality Installation Specification
5.3001.4d	ANSI/ACCA Manual CS	Commercial Applications, Systems and Equipment
5.3001.4d	ANSI/ACCA Manual J	Residential Load Calculation
5.3001.4d	ANSI/ACCA Manual S	Residential Equipment Selection
5.3001.4d	ANSI/ASHRAE Standard 90.2 - 2007	Energy Efficient Design of Low-Rise Residential Buildings
5.3001.4e	ANSI/ASHRAE Standard 90.2 - 2007	Energy Efficient Design of Low-Rise Residential Buildings
5.3001.4f	ANSI/ASHRAE Standard 90.2 - 2007	Energy Efficient Design of Low-Rise Residential Buildings
5.3001.5a	ANSI/ACCA Manual D	Residential Duct Systems
5.3001.5a	ANSI/ACCA Manual Q	Low Pressure, Low Velocity Duct System Design
5.3001.5a	ASHRAE	Fundamentals Handbook
5.3001.5b	ANSI/ACCA Manual D	Residential Duct Systems
5.3001.5b	ASHRAE	Fundamentals Handbook
5.3001.5c	ANSI/ACCA Manual D	Residential Duct Systems
5.3001.5c	ASHRAE	Fundamentals Handbook
5.3001.5e	NAIMA	Fibrous Glass Duct Construction Standards
5.3001.5e	SMACNA	Duct Construction Standard
5.3001.5f	ASHRAE	Fundamentals Handbook
5.3001.5h	ACCA Manual T	Air Distribution Basics
5.3001.5i	ACCA Manual T	Air Distribution Basics
5.3001.5l	SMACNA	Duct Construction Standard
5.3001.6a	ANSI/ACCA 5 - 2010 QI	HVAC Quality Installation Specification
5.3001.6a	ANSI/ACCA Manual J	Residential Load Calculation
5.3001.6a	ANSI/ACCA Manual N	Commercial Load Calculation for Small Commercial Buildings
5.3001.6a	ASHRAE	General
5.3001.6b	ANSI/ACCA 5 - 2010 QI	HVAC Quality Installation Specification
5.3001.6b	ANSI/ACCA Manual CS	Commercial Applications, Systems and Equipment
5.3001.6b	ANSI/ACCA Manual S	Residential Equipment Selection
5.3001.6b	ASHRAE	General
5.3001.6h	ANSI/ASHRAE Standard 90.1-2010	Energy Standard for Buildings Except Low-Rise Residential Buildings
5.3002.12a	ANSI/ASHRAE Standard 90.1-2010	Energy Standard for Buildings Except Low-Rise Residential Buildings

5.3002.12a	ASHRAE Standard 15	Safety Standard for Refrigeration Systems
5.3002.12ac	ANSI/ACCA/ASHRAE Standard 180-2008	Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems
5.3002.12af	ANSI/ACCA/ASHRAE Standard 180-2008	Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems
5.3002.12b	ANSI/ACCA/ASHRAE Standard 180-2008	Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems
5.3002.12d	ANSI/ASHRAE Standard 90.1-2010	Energy Standard for Buildings Except Low-Rise Residential Buildings
5.3002.12e	ANSI/ACCA/ASHRAE Standard 180-2008	Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems
5.3002.12h	ANSI/ACCA/ASHRAE Standard 180-2008	Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems
5.3002.12j	ASHRAE Standard 15	Safety Standard for Refrigeration Systems
5.3002.12n	ANSI/ACCA/ASHRAE Standard 180-2008	Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems
5.3002.12q	ANSI/ACCA/ASHRAE Standard 180-2008	Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems
5.3002.12t	ANSI/ACCA/ASHRAE Standard 180-2008	Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems
5.3002.12v	ANSI/ASHRAE Standard 90.1-2010	Energy Standard for Buildings Except Low-Rise Residential Buildings
5.3002.12w	ANSI/ACCA/ASHRAE Standard 180-2008	Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems
5.3002.12y	ANSI/ASHRAE Standard 90.1-2010	Energy Standard for Buildings Except Low-Rise Residential Buildings
5.3002.12z	ANSI/ACCA/ASHRAE Standard 180-2008	Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems
5.3002.13a	OSHA	9 CFR 1926 Subpart M - Fall Protection
5.3002.13c	NAHB-OSHA	Jobsite Safety Handbook, Second Edition: Electrical
5.3002.13c	OSHA	29 CFR 1926 Subpart K – Electrical
5.3002.13d	EPA	40 CFR 608
5.3002.13d	EPA	40 CFR 82.154
5.3002.16b	NFPA 90B	Standard for the Installation of Warm Air Heating and Air-Conditioning Systems
5.3002.16c	NFPA 90B	Standard for the Installation of Warm Air Heating and Air-Conditioning Systems

5.3002.16h	NFPA 90A	Standard for the Installation of Air-Conditioning and Ventilating Systems
5.3002.16h	NFPA 90B	Standard for the Installation of Warm Air Heating and Air-Conditioning Systems
5.3002.16h	SMACNA	Duct Construction Standard
5.3002.4a	OSHA 1926	Safety and Health Regulations for Construction, Subpart M
5.3002.4c	NAHB-OSHA	Jobsite Safety Handbook
5.3002.4c	OSHA 1926	Safety and Health Regulations for Construction, Subpart K
5.3002.4d	EPA	40 CFR 82.154
5.3002.7b	NFPA 90B	Standard for the Installation of Warm Air Heating and Air-Conditioning Systems
5.3002.7c	NFPA 90B	Standard for the Installation of Warm Air Heating and Air-Conditioning Systems
5.3002.7h	SMACNA	Duct Construction Standard
5.3003.10a	2012 IRC	M1411.3
5.3003.10c	2012 IRC	M1411.3
5.3003.10d	2012 IRC	M1411.3
5.3003.10e	2012 IRC	M1411.3
5.3003.10f	2012 IRC	M1411.3
5.3003.18a	BPI	General
5.3003.18b	NFPA 54/ANSI/AGA Z223.1	National Fuel Gas Code
5.3003.18c	NFPA 31	Standard for the Installation of Oil-Burning Equipment
5.3003.19d	EPA	40 CFR 608
5.3003.2 (all)	NFPA 31	Standard for the Installation of Oil-Burning Equipment
5.3003.20a	NFPA 70	National Electrical Code
5.3003.20b	NFPA 70	National Electrical Code
5.3003.20e	NFPA 70	National Electrical Code
5.3003.20f	NFPA 70	National Electrical Code
5.3003.20g	NFPA 70	National Electrical Code
5.3003.20h	NFPA 70	National Electrical Code
5.3003.21d	ANSI/ACCA 5 - 2010 QI	HVAC Quality Installation Specification
5.3003.21d	ANSI/ASHRAE Standard 111	Measurement, Testing, Adjusting and Balancing of Building HVAC Systems
5.3003.21h	ANSI/ACCA 5 - 2010 QI	HVAC Quality Installation Specification
5.3003.21h	ANSI/ASHRAE Standard 111	Measurement, Testing, Adjusting and Balancing of Building HVAC Systems
5.3003.21l	ANSI/ACCA 5 - 2010 QI	HVAC Quality Installation Specification
5.3003.21l	ANSI/ASHRAE Standard 111	Measurement, Testing, Adjusting and Balancing of Building HVAC Systems
5.3003.21m	OSHA	General
5.3003.22b	ANSI/ACCA 5 - 2010 QI	HVAC Quality Installation Specification
5.3003.22c	NFPA 31	Standard for the Installation of Oil-Burning Equipment
5.3003.22d	NFPA 31	Standard for the Installation of Oil-Burning Equipment

5.3003.22e	NFPA 31	Standard for the Installation of Oil-Burning Equipment
5.3003.22f	NFPA 31	Standard for the Installation of Oil-Burning Equipment
5.3003.22g	NFPA 31	Standard for the Installation of Oil-Burning Equipment
5.3003.22h	NFPA 31	Standard for the Installation of Oil-Burning Equipment
5.3003.22i	NFPA 31	Standard for the Installation of Oil-Burning Equipment
5.3003.22j	NFPA 31	Standard for the Installation of Oil-Burning Equipment
5.3003.22k	NFPA 31	Standard for the Installation of Oil-Burning Equipment
5.3003.22l	NFPA 31	Standard for the Installation of Oil-Burning Equipment
5.3003.23c	ANSI/ACCA 5 - 2010 QI	HVAC Quality Installation Specification
5.3003.23d	ANSI/ACCA 5 - 2010 QI	HVAC Quality Installation Specification
5.3003.24c	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
5.3003.25d	EPA	40 CFR 608
5.3003.26a	NFPA 70	National Electrical Code
5.3003.26b	NFPA 70	National Electrical Code
5.3003.26e	NFPA 70	National Electrical Code
5.3003.26f	NFPA 70	National Electrical Code
5.3003.26g	NFPA 70	National Electrical Code
5.3003.26h	NFPA 70	National Electrical Code
5.3003.26j	NFPA 70A	National Electrical Code® Requirements for One- and Two-Family Dwellings
5.3003.26j	NFPA 70E	Standard for Electrical Safety in the Workplace®
5.3003.26k	NFPA 70A	National Electrical Code® Requirements for One- and Two-Family Dwellings
5.3003.26k	NFPA 70E	Standard for Electrical Safety in the Workplace®
5.3003.27	OSHA	General
5.3003.27d	ANSI/ACCA 5 - 2010 QI	HVAC Quality Installation Specification
5.3003.27d	ANSI/ASHRAE Standard 111	Measurement, Testing, Adjusting and Balancing of Building HVAC Systems
5.3003.27h	ANSI/ACCA 5 - 2010 QI	HVAC Quality Installation Specification
5.3003.27h	ANSI/ASHRAE Standard 111	Measurement, Testing, Adjusting and Balancing of Building HVAC Systems
5.3003.27i	ANSI/ACCA 5 - 2010 QI	HVAC Quality Installation Specification
5.3003.27i	ANSI/ASHRAE Standard 111	Measurement, Testing, Adjusting and Balancing of Building HVAC Systems
5.3003.28a	ANSI/ACCA 5 - 2010 QI	HVAC Quality Installation Specification
5.3003.28d	NFPA 70	National Electrical Code

5.3003.28f	ANSI/ACCA 4 -- 2007	Maintenance of Residential HVAC Systems in One- and Two-Family Dwellings Less Than Three Stories, 2007
5.3003.28f	ANSI/ACCA/ASHRAE Standard 180-2008	Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems
5.3003.2d	BPI-1100-T-2012	Home Energy Auditing Standard
5.3003.2h	BPI-1100-T-2012	Home Energy Auditing Standard
5.3003.30c	ANSI/ACCA 5 - 2010 QI	HVAC Quality Installation Specification
5.3003.30d	ANSI/ACCA 5 - 2010 QI	HVAC Quality Installation Specification
5.3003.32c	ANSI/ACCA 4 -- 2007	Maintenance of Residential HVAC Systems in One- and Two-Family Dwellings Less Than Three Stories, 2007
5.3003.32c	ANSI/ACCA/ASHRAE Standard 180-2008	Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems
5.3003.33a	NFPA 31	Standard for the Installation of Oil-Burning Equipment
5.3003.33b	NFPA 31	Standard for the Installation of Oil-Burning Equipment
5.3003.34a	NFPA 54/ANSI/AGA Z223.1	National Fuel Gas Code
5.3003.34b	NFPA 54/ANSI/AGA Z223.1	National Fuel Gas Code
5.3003.34c	NFPA 54/ANSI/AGA Z223.1	National Fuel Gas Code
5.3003.34d	NFPA 54/ANSI/AGA Z223.1	National Fuel Gas Code
5.3003.35a	NFPA 31	Standard for the Installation of Oil-Burning Equipment
5.3003.35a	NFPA 54/ANSI/AGA Z223.1	National Fuel Gas Code
5.3003.35c	NFPA 211	Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances
5.3003.35c	NFPA 31	Standard for the Installation of Oil-Burning Equipment
5.3003.35c	NFPA 54/ANSI/AGA Z223.1	National Fuel Gas Code
5.3003.35d	NFPA 31	Standard for the Installation of Oil-Burning Equipment
5.3003.35d	NFPA 54/ANSI/AGA Z223.1	National Fuel Gas Code
5.3003.36	SMACNA	Duct Construction Standard
5.3003.36	SMACNA	Duct Construction Standard
5.3003.36	SMACNA	Duct Construction Standard
5.3003.36	ASTM C1193 - 09	Standard Guide for Use of Joint Sealants
5.3003.36	Air Diffusion Council	Flex Duct Standard
5.3003.36	NAIMA	Fibrous Glass Duct Construction Standards
5.3003.36	SMACNA	Duct Construction Standard
5.3003.36	SMACNA	Duct Construction Standard
5.3003.36	NFPA 90A	Standard for the Installation of Air-Conditioning and Ventilating Systems
5.3003.36	NFPA 90B	Standard for the Installation of Warm Air Heating and Air-Conditioning Systems

5.3003.36	SMACNA	Duct Construction Standard
5.3003.36	UL 181A	Closure Systems for Use With Rigid Air Ducts
5.3003.36	SMACNA	Duct Construction Standard
5.3003.36	ACCA Manual T	Air Distribution Basics
5.3003.36	SMACNA	Duct Construction Standard
5.3003.36	SMACNA	Duct Construction Standard
5.3003.36	ANSI/ACCA 5 - 2010 QI	HVAC Quality Installation Specification
5.3003.36	ASHRAE	General
5.3003.36	SMACNA	Duct Construction Standard
5.3003.36	SMACNA	Duct Construction Standard
5.3003.37a	EPA	40 CFR 271.13
5.3003.37b	OSHA 3142-09R	Lead in Construction
5.3003.37c	ASTM C1193 - 09	Standard Guide for Use of Joint Sealants
5.3003.37e	ANSI/ACCA 5 - 2010 QI	HVAC Quality Installation Specification
5.3003.37e	ANSI/ASHRAE Standard 111	Measurement, Testing, Adjusting and Balancing of Building HVAC Systems
5.3003.37m	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
5.3003.39a	NFPA 54/ANSI/AGA Z223.1	National Fuel Gas Code
5.3003.39b	NFPA 54/ANSI/AGA Z223.1	National Fuel Gas Code
5.3003.39c	AGA	General
5.3003.39c	NFPA	General
5.3003.40a	NFPA 31	Standard for the Installation of Oil-Burning Equipment
5.3003.40b	NFPA 31	Standard for the Installation of Oil-Burning Equipment
5.3003.41a	NFPA 31	Standard for the Installation of Oil-Burning Equipment
5.3003.41a	NFPA 54/ANSI/AGA Z223.1	National Fuel Gas Code
5.3003.41c	NFPA 31	Standard for the Installation of Oil-Burning Equipment
5.3003.41c	NFPA 54/ANSI/AGA Z223.1	National Fuel Gas Code
5.3003.42a	SMACNA	Duct Construction Standard
5.3003.42b	SMACNA	Duct Construction Standard
5.3003.42d	SMACNA	Duct Construction Standard
5.3003.42e	Air Diffusion Council	Flex Duct Standard
5.3003.42e	NAIMA	Fibrous Glass Duct Construction Standards
5.3003.42e	SMACNA	Duct Construction Standard
5.3003.42g	SMACNA	Duct Construction Standard
5.3003.42h	NFPA 90A	Standard for the Installation of Air-Conditioning and Ventilating Systems
5.3003.42h	NFPA 90B	Standard for the Installation of Warm Air Heating and Air-Conditioning Systems
5.3003.42h	SMACNA	Duct Construction Standard
5.3003.42i	UL 181A	Closure Systems for Use With Rigid Air Ducts

5.3003.42j	SMACNA	Duct Construction Standard
5.3003.42k	SMACNA	Duct Construction Standard
5.3003.42m	SMACNA	Duct Construction Standard
5.3003.42n	ANSI/ACCA 5 - 2010 QI	HVAC Quality Installation Specification
5.3003.42r	SMACNA	Duct Construction Standard
5.3003.42s	SMACNA	Duct Construction Standard
5.3003.43a	EPA	40 CFR 271.13
5.3003.43b	OSHA 3142-09R	Lead in Construction
5.3003.43c	ASTM C1193 - 09	Standard Guide for Use of Joint Sealants
5.3003.43e	ANSI/ACCA 5 - 2010 QI	HVAC Quality Installation Specification
5.3003.43e	ANSI/ASHRAE Standard 111	Measurement, Testing, Adjusting and Balancing of Building HVAC Systems
5.3003.43m	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
5.3003.4d	NFPA 70	National Electrical Code®
5.3003.5a	2012 IRC	M1411.5
5.3003.5b	2012 IRC	N1103.3.1
5.3003.7d	ANSI Z223.1	National Fuel Gas Code
5.3003.7d	NFPA 31	Standard for the Installation of Oil-Burning Equipment
5.3003.7d	NFPA 54	National Fuel Gas Code
5.3003.7d	NFPA 58	Liquefied Petroleum Gas Code
5.3003.7h	ANSI/ASHRAE 62.2	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
5.3003.7i	ANSI/ASHRAE 62.2	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
5.3003.8b	2012 IRC	M1202.3
5.3003.8b	2012 IRC	M1413
5.3003.8b	2012 IRC	P2902
5.3003.9j	2012 IRC	N1103.1
5.3088.3a	ANSI/ACCA 5 - 2010 QI	HVAC Quality Installation Specification
5.3088.3b	ANSI/ACCA 5 - 2010 QI	HVAC Quality Installation Specification
5.3088.3c	ANSI/ACCA 5 - 2010 QI	HVAC Quality Installation Specification
5.3088.3d	ANSI/ACCA 5 - 2010 QI	HVAC Quality Installation Specification
5.3088.3e	ANSI/ACCA 5 - 2010 QI	HVAC Quality Installation Specification
5.3088.3f	ANSI/ACCA 5 - 2010 QI	HVAC Quality Installation Specification
5.3101.1a	ANSI/ACCA J	Residential Load Calculation
5.3101.1b	ANSI/ACCA S	Residential Equipment Selection
5.3101.2a	ANSI/ACCA J	Residential Load Calculation
5.3102.19b	ANSI/ACCA Manual J	Residential Load Calculation
5.3102.19b	ANSI/ACCA Manual N	Commercial Load Calculation for Small Commercial Buildings
5.3102.19b	ASHRAE	General
5.3102.19b	ASHRAE Standard 183	Peak Cooling and Heating Load Calculations in Buildings Except Low-Rise Residential Buildings

5.3102.19i	IPC	International Plumbing Code, Section 101.3
5.3102.19i	IPC	International Plumbing Code, Section 101.4
5.3102.19i	IPC	International Plumbing Code, Section 301.7
5.3102.19i	UPC	Universal Plumbing Code, Section 101.2
5.3102.1b	ANSI/ACCA Manual J	Residential Load Calculation
5.3102.1b	ANSI/ACCA Manual N	Commercial Load Calculation for Small Commercial Buildings
5.3102.1b	ASHRAE	General
5.3102.1b	ASHRAE Standard 183	Peak Cooling and Heating Load Calculations in Buildings Except Low-Rise Residential Buildings
5.3102.1h	ANSI/ACCA 5 - 2010 QI	HVAC Quality Installation Specification
5.3102.24c	NFPA 31	Standard for the Installation of Oil-Burning Equipment, Section 3.3.50
5.3102.26b	NFPA 31	Standard for the Installation of Oil-Burning Equipment, Section 3.3.50
5.3102.27d	EPA	General
5.3102.28a	ANSI/ACCA 4 -- 2007	Maintenance of Residential HVAC Systems in One- and Two-Family Dwellings Less Than Three Stories, 2007
5.3102.28a	ANSI/ASHRAE/ACCA Standard 180 - 2008	Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems
5.3102.28b	ANSI/ACCA 4 -- 2007	Maintenance of Residential HVAC Systems in One- and Two-Family Dwellings Less Than Three Stories, 2007
5.3102.28b	ANSI/ASHRAE/ACCA Standard 180 - 2008	Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems
5.3102.28f	NFPA 31	Standard for the Installation of Oil-Burning Equipment, Section 3.3.50
5.3102.2e	ANSI	General
5.3102.31f	ANSI/ASHRAE Standard 90.1-2010	Energy Standard for Buildings Except Low-Rise Residential Buildings
5.3102.31f	IECC 2012	International Energy Conservation Code
5.3102.37b	EPA	General
5.3102.37c	Federal Fair Housing Act	General
5.3102.37c	NFPA 70A	National Electrical Code® Requirements for One- and Two-Family Dwellings
5.3102.37e	EPA	40 CFR 271.13
5.3102.37f	ANSI/ACCA 5 -- 2010 QI	HVAC Quality Installation Specification
5.3102.37f	ANSI/ACCA Manual S	Residential Equipment Selection
5.3102.37f	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
5.3102.38a	ANSI/ACCA 5 - 2010 QI	HVAC Quality Installation Specification
5.3102.38e	ASHRAE	General

5.3102.38e	LEED	NC/EB
5.3103.1f	ANSI/ACCA 5 - 2010 QI	HVAC Quality Installation Specification
5.3103.1f	ANSI/ASHRAE Standard 111	Measurement, Testing, Adjusting and Balancing of Building HVAC Systems
5.3103.4d	ANSI/ACCA 5 - 2010 QI	HVAC Quality Installation Specification
5.3103.4d	ANSI/ASHRAE Standard 111	Measurement, Testing, Adjusting and Balancing of Building HVAC Systems
5.3103.4e	ANSI/ASHRAE Standard 90.1-2010	Energy Standard for Buildings Except Low-Rise Residential Buildings
5.3103.4e	IECC 2012	International Energy Conservation Code
5.3103.7e	ANSI/ASHRAE Standard 90.1-2010	Energy Standard for Buildings Except Low-Rise Residential Buildings
5.3103.7e	IECC 2012	International Energy Conservation Code
5.3103.8e	ANSI/ASHRAE Standard 90.1-2010	Energy Standard for Buildings Except Low-Rise Residential Buildings
5.3103.8e	IECC 2012	International Energy Conservation Code
5.3103.9e	ANSI/ASHRAE Standard 90.1-2010	Energy Standard for Buildings Except Low-Rise Residential Buildings
5.3103.9e	IECC 2012	International Energy Conservation Code
5.3104.10a	ASTM E1998 - 02(2007)	Standard Guide for Assessing Depressurization-Induced Backdrafting and Spillage from Vented Combustion Appliances
5.3104.10a	BPI-1100-T-2012	Home Energy Auditing Standard
5.3104.10b	ANSI/ACCA 4 -- 2007	Maintenance of Residential HVAC Systems in One- and Two-Family Dwellings Less Than Three Stories, 2007
5.3104.10b	ANSI/ACCA 4 -- 2007	Maintenance of Residential HVAC Systems in One- and Two-Family Dwellings Less Than Three Stories, 2007
5.3104.10b	ANSI/ASHRAE/ACCA Standard 180 - 2008	Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems
5.3104.10b	NFPA 54/ANSI/AGA Z223.1	National Fuel Gas Code
5.3104.10c	NFPA 54/ANSI/AGA Z223.1	National Fuel Gas Code
5.3104.10d	NFPA 54/ANSI/AGA Z223.1	National Fuel Gas Code
5.3104.10e	NFPA 54/ANSI/AGA Z223.1	National Fuel Gas Code
5.3104.10f	NFPA 54/ANSI/AGA Z223.1	National Fuel Gas Code
5.3104.10g	ASTM E1998 - 02(2007)	Standard Guide for Assessing Depressurization-Induced Backdrafting and Spillage from Vented Combustion Appliances
5.3104.10g	BPI	General
5.3104.10g	NATE	General
5.3104.10h	NFPA	General
5.3104.10h	NFPA 720	Standard for the Installation of Carbon Monoxide Detection and Warning Equipment

5.3104.10i	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
5.3104.11f	ANSI/ASHRAE Standard 90.1-2010	Energy Standard for Buildings Except Low-Rise Residential Buildings
5.3104.11f	IECC 2012	International Energy Conservation Code
5.3104.12f	ANSI/ASHRAE Standard 90.1-2010	Energy Standard for Buildings Except Low-Rise Residential Buildings
5.3104.12f	IECC 2012	International Energy Conservation Code
5.3104.2a	ANSI/ACCA Standard 4 QM-2007	Maintenance for Residential HVAC Systems
5.3104.2b	ANSI/ACCA Standard 4 QM-2007	Maintenance for Residential HVAC Systems
5.3104.2e	2012 IRC	G2427
5.3104.2f	BPI-1100-T-2012	Home Energy Auditing Standard
5.3104.2h	ANSI/ASHRAE 62.2	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
5.3104.3g	2012 IRC	M2002.3
5.3104.3h	2012 IRC	M2002.5
5.3104.3i	2012 IRC	M2002.5
5.3104.3j	2012 IRC	M2003
5.3104.3k	2012 IRC	M2001
5.3104.3q	ANSI/ASHRAE 62.2	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
5.3104.3r	ANSI/ASHRAE 62.2	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
5.3104.9d	NFPA 720	Standard for the Installation of Carbon Monoxide Detection and Warning Equipment
5.3104.9d	NFPA 720	Standard for the Installation of Carbon Monoxide Detection and Warning Equipment
5.3104.9g	NFPA 54/ANSI/AGA Z223.1	National Fuel Gas Code
5.3104.9i	NFPA 54/ANSI/AGA Z223.1	National Fuel Gas Code
5.3104.9j	NFPA 54/ANSI/AGA Z223.1	National Fuel Gas Code
5.3104.9m	NFPA 54/ANSI/AGA Z223.1	National Fuel Gas Code
5.3104.9q	NFPA 54/ANSI/AGA Z223.1	National Fuel Gas Code
5.3104.9r	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
5.3104.9t	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
5.3202.2a	LEED	New Construction
5.3301.1a	NFPA 70	National Electrical Code® Requirements for One- and Two-Family Dwellings, Article 314.27 C

5.3301.1b	ENERGY STAR	General
5.3301.1c	NFPA 70	National Electrical Code® Requirements for One- and Two-Family Dwellings, Section 903
5.3301.1c	NFPA 70E	Standard for Electrical Safety in the Workplace®
5.3301.1c	EISA	General
5.3301.1c	ENERGY STAR	General
5.3301.1c	NFPA 13R	Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies
5.3301.1c	OSHA 1910	Occupational Safety and Health Standards, Subpart S
5.3301.1f	EPA	General
5.3301.1h	EPA	General
5.3302.1a	NFPA 70	National Electrical Code, Section 440
5.3302.1b	ENERGY STAR	General
5.3302.1c	ANSI/NFPA 101	Building Exit Codes
5.3302.1c	ASTM C1193 - 09	Standard Guide for Use of Joint Sealants
5.3302.1c	ICC/ANSI A117.1	Accessible and Usable Buildings and Facilities
5.3302.1c	NFPA 70	National Electrical Code, Section 440
5.3302.1d	Clean Air Act	Section 608
6.6002.1 (all)	SMACNA	Duct Construction Standards
6.6002.1a	2012 IRC	M1601.1
6.6002.1c	2012 IRC	M1601.4.3
6.6002.1d	2012 IRC	Chapter 16
6.6002.1d	2012 IRC	M1601.1.1
6.6002.1e	2012 IRC	M1503.2
6.6002.1e	2012 IRC	M1601.2
6.6002.2b	2012 IRC	R303.5
6.6002.2c	2012 IRC	Chapter 16
6.6002.2c	2012 IRC	M1601.1.1
6.6002.2d	2012 IRC	N1102.4
6.6002.2e	2012 IRC	R303.6
6.6002.2f	2012 IRC	M1506.2
6.6002.2g	2012 IRC	M1503.2
6.6003.1b	2012 IRC	E3403
6.6003.1c	2012 IRC	M1307
6.6003.1e	2012 IRC	Chapter 16
6.6003.1e	2012 IRC	M1601.1.1
6.6003.1f	2012 IRC	N1103.2
6.6003.1g	2012 IRC	N1103.2
6.6003.1h	2012 IRC	M1507
6.6003.1h	ANSI/ASHRAE 111-2008	Measurement, Testing, Adjusting and Balancing of Building HVAC Systems
6.6003.1i	2012 IRC	N1103.2
6.6003.1j	2012 IRC	R102.7
6.6003.2a	2012 IRC	E3403

6.6003.2b	2012 IRC	M1401.2
6.6003.2b	NFPA 70	National Electrical Code®
6.6003.2c	2012 IRC	M1307
6.6003.2d	2012 IRC	N1103.5
6.6003.2e	2012 IRC	Chapter 16
6.6003.2e	2012 IRC	M1601.1.1
6.6003.2f	2012 IRC	N1103.2
6.6003.2g	2012 IRC	M1507
6.6003.2g	ANSI/ASHRAE 111-2008	Measurement, Testing, Adjusting and Balancing of Building HVAC Systems
6.6003.2h	2012 IRC	N1103.2
6.6003.2i	2012 IRC	R102.7
6.6003.2i	ANSI Z223.1	National Fuel Gas Code
6.6003.2i	NFPA 54	National Fuel Gas Code
6.6003.3b	2012 IRC	E3403
6.6003.3c	2012 IRC	M1307
6.6003.3d	2012 IRC	Chapter 16
6.6003.3d	2012 IRC	N1102.4
6.6003.3f	2012 IRC	N1103.2
6.6003.3g	2012 IRC	N1103.2
6.6003.3i	2012 IRC	M1507
6.6003.3i	2012 IRC	N1103.2
6.6003.3i	ANSI/ASHRAE 111-2008	Measurement, Testing, Adjusting and Balancing of Building HVAC Systems
6.6003.3j	2012 IRC	R102.7
6.6003.3j	ANSI Z223.1	National Fuel Gas Code
6.6003.3j	NFPA 54	National Fuel Gas Code
6.6003.4a	2012 IRC	E3403
6.6003.4b	2012 IRC	M1401.2
6.6003.4b	NFPA 70	National Electrical Code®
6.6003.4c	2012 IRC	M1307
6.6003.4d	2012 IRC	N1103.5
6.6003.4e	2012 IRC	M1502
6.6003.4e	2012 IRC	M1503
6.6003.4f	2012 IRC	Chapter 16
6.6003.4f	2012 IRC	M1601.1.1
6.6003.4h	2012 IRC	N1102.4.1.1
6.6003.4i	2012 IRC	M1507
6.6003.4j	2012 IRC	N1103.2
6.6003.4k	2012 IRC	R102.7
6.6003.4k	ANSI Z223.1	National Fuel Gas Code
6.6003.4k	NFPA 54	National Fuel Gas Code
6.6003.5a	IMC	International Mechanical Code
6.6003.5a	IMC	International Mechanical Code
6.6003.5b	2012 IRC	N1102.4.1.1
6.6003.5b	2012 IRC	N1103.2
6.6003.5c	2012 IRC	R102.7
6.6003.5c	ANSI Z223.1	National Fuel Gas Code
6.6003.5c	NFPA 54	National Fuel Gas Code

6.6004.1b	ANSI/ACCA 5 - 2010 QI	HVAC Quality Installation Specification
6.6004.1b	ANSI/ASHRAE Standard 111	Measurement, Testing, Adjusting and Balancing of Building HVAC Systems
6.6004.1b	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
6.6004.1c	HVI	General
6.6004.1c	NEMA	National Electricla Manufacturers Association
6.6004.1e	NFPA 70	National Electrical Code
6.6004.1l	SMACNA	Duct Construction Standard
6.6004.1n	ASTM C1193 - 09	Standard Guide for Use of Joint Sealants
6.6004.1o	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings, Addendum J
6.6004.1o	ASTM C1193 - 09	Standard Guide for Use of Joint Sealants
6.6004.1p	ANSI/ACCA 5 - 2010 QI	HVAC Quality Installation Specification
6.6004.1p	ANSI/ASHRAE Standard 111	Measurement, Testing, Adjusting and Balancing of Building HVAC Systems
6.6004.1q	ASTM E1998 - 02(2007)	Standard Guide for Assessing Depressurization-Induced Backdrafting and Spillage from Vented Combustion Appliances
6.6004.2b	ANSI/ACCA 5 - 2010 QI	HVAC Quality Installation Specification
6.6004.2b	ANSI/ASHRAE Standard 111	Measurement, Testing, Adjusting and Balancing of Building HVAC Systems
6.6004.2b	ANSI/ASHRAE Standard 62.1-2010	Ventilation and Acceptable Indoor Air Quality
6.6004.2b	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
6.6004.2c	NFPA 54/ANSI/AGA Z223.1	National Fuel Gas Code
6.6004.2d	NFPA 70	National Electrical Code
6.6004.2g	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
6.6004.2g	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
6.6004.2i	SMACNA	Duct Construction Standard
6.6004.2k	ASTM C1193 - 09	Standard Guide for Use of Joint Sealants
6.6004.2l	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings, Section 6.1
6.6004.2l	ASTM C1193 - 09	Standard Guide for Use of Joint Sealants
6.6004.2n	ASTM E1998 - 02(2007)	Standard Guide for Assessing Depressurization-Induced Backdrafting and Spillage from Vented Combustion Appliances

6.6004.3b	ANSI/ASHRAE Standard 62.1-2010	Ventilation and Acceptable Indoor Air Quality, Table 5-1
6.6004.3b	ASTM E1998 - 02(2007)	Standard Guide for Assessing Depressurization-Induced Backdrafting and Spillage from Vented Combustion Appliances
6.6004.3b	NEMA	National Electricla Manufacturers Association
6.6004.3c	NFPA 70	National Electrical Code
6.6004.3g	ANSI/ACCA 5 - 2010 QI	HVAC Quality Installation Specification
6.6004.3g	ANSI/ASHRAE Standard 111	Measurement, Testing, Adjusting and Balancing of Building HVAC Systems
6.6004.3h	ASTM E1998 - 02(2007)	Standard Guide for Assessing Depressurization-Induced Backdrafting and Spillage from Vented Combustion Appliances
6.6005.1a	2012 IRC	M1502
6.6005.1a	ANSI/ASHRAE 62.2	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
6.6005.1a	IMC	International Mechanical Code
6.6005.1b	2012 IRC	M1502.3
6.6005.1c	2012 IRC	G2439.4
6.6005.1e	ANSI/ASHRAE 62.2	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
6.6005.2a	2012 IRC	General
6.6005.2b	ANSI/ASHRAE 62.2	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
6.6005.2c	2012 IRC	M1503.1
6.6005.2c	2012 IRC	M1503.2
6.6005.2d	ANSI/ASHRAE 62.2	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
6.6005.2f	2012 IRC	G2407
6.6005.2f	2012 IRC	G2447
6.6005.3b	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
6.6005.3c	ANSI/ASHRAE Standard 62.1-2010	Ventilation and Acceptable Indoor Air Quality, Table 5-1
6.6005.3f	ASTM E1998 - 02(2007)	Standard Guide for Assessing Depressurization-Induced Backdrafting and Spillage from Vented Combustion Appliances
6.6005.3g	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
6.6005.4b	NFPA 70	National Electrical Code

6.6005.4b	OSHA	Technical Manual Section VIII: Chapter 1, part III
6.6005.4c	HVI 2100	General
6.6005.4d	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
6.6005.4e	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
6.6005.4e	IMC-2009	International Mechanical Code, Section 505
6.6005.4f	ANSI/ASHRAE Standard 62.1-2010	Ventilation and Acceptable Indoor Air Quality, Table 5-1
6.6005.4f	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
6.6005.4g	IMC-2009	International Mechanical Code, Section 504.5
6.6005.4i	ASTM E1998 - 02(2007)	Standard Guide for Assessing Depressurization-Induced Backdrafting and Spillage from Vented Combustion Appliances
6.6005.4j	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
6.6102.1c	2012 IRC	M1601.4.3
6.6102.1d	2012 IRC	M1601.1.1
6.6102.1d	2012 IRC	M1601.4.1
6.6102.1e	IMC	International Mechanical Code
6.6102.1e	NFPA 90A/B	Standard for the Installation of Air-Conditioning and Ventilating Systems / Standard for the Installation of Warm Air Heating and Air-Conditioning Systems
6.6102.1f	2012 IRC	R303.5.1
6.6102.1f	ANSI/ASHRAE 62.2	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
6.6102.2b	2012 IRC	R303.5
6.6102.2d	2012 IRC	N1103.5
6.6102.2e	2012 IRC	Chapter 16
6.6102.2e	2012 IRC	M1601.1.1
6.6102.2f	2012 IRC	R303.6
6.6102.2h	2012 IRC	R303.5.1
6.6102.3a	BPI 104	Envelope Professional
6.6102.3b	2012 IRC	E3403
6.6102.3c	2012 IRC	M1401.2
6.6102.3e	2012 IRC	N1103.5
6.6102.3f	ANSI/ASHRAE 52.2	Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size

6.6102.3f	ANSI/ASHRAE 62.2	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
6.6102.6c	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
6.6102.6g	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
6.6102.6g	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
6.6102.6h	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
6.6102.7a	ANSI/ACCA Manual D	Residential Duct Systems
6.6102.7a	ANSI/ACCA Manual Q	Low Pressure, Low Velocity Duct System Design
6.6102.7a	SMACNA	Duct Construction Standard
6.6102.7c	SMACNA	Duct Construction Standard
6.6102.7d	SMACNA	Duct Construction Standard
6.6102.7e	SMACNA	Duct Construction Standard
6.6102.7f	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
6.6103.1a	2012 IRC	E3403
6.6103.1b	2012 IRC	M1401.2
6.6103.1c	2012 IRC	M1307
6.6103.1d	2012 IRC	N1103.5
6.6103.1e	2012 IRC	M1601.4.1
6.6103.1f	ANSI/ASHRAE 52.2	Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size
6.6103.1f	ANSI/ASHRAE 62.2	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
6.6103.1h	2012 IRC	N1103.2
6.6103.1h	2012 IRC	R302.9
6.6104.1b	ANSI/ACCA 5 - 2010 QI	HVAC Quality Installation Specification
6.6104.1b	ANSI/ASHRAE Standard 111	Measurement, Testing, Adjusting and Balancing of Building HVAC Systems
6.6104.1b	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
6.6104.1c	NEMA	National Electrical Manufacturers Association
6.6104.1d	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings

6.6104.1g	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
6.6104.1i	NFPA 70	National Electrical Code
6.6104.1m	SMACNA	Duct Construction Standard
6.6104.1o	ASTM C1193 - 09	Standard Guide for Use of Joint Sealants
6.6104.1p	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings, Addendum J
6.6104.1q	ANSI/ACCA 5 - 2010 QI	HVAC Quality Installation Specification
6.6104.1q	ANSI/ASHRAE Standard 111	Measurement, Testing, Adjusting and Balancing of Building HVAC Systems
6.6104.2b	NFPA 70	National Electrical Code
6.6104.2c	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
6.6201.1a	ANSI/ASHRAE 62.2	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
6.6201.1b	ANSI/ASHRAE 62.2	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
6.6201.1c	ANSI/ASHRAE 62.2	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
6.6201.4g	OSHA	General
6.6202.1c	2012 IRC	E3403
6.6202.2a	2012 IRC	E3403
6.6202.2b	2012 IRC	M1401.2
6.6202.2c	2012 IRC	M1401.1
6.6202.2c	2012 IRC	M1601.1
6.6202.2c	ANSI/ACCA D	Residential Duct Systems
6.6202.2d	2012 IRC	N1103.5
6.6202.2e	2012 IRC	R303.5
6.6202.2f	2012 IRC	Chapter 16
6.6202.2f	2012 IRC	N1103.2.2
6.6202.2i	2012 IRC	Chapter 16
6.6202.3c	UL 181	Factory-Made Air Ducts and Air Connectors
6.6202.3e	ANSI/ACCA 5 - 2010 QI	HVAC Quality Installation Specification
6.6202.3e	ANSI/ASHRAE Standard 111	Measurement, Testing, Adjusting and Balancing of Building HVAC Systems
6.6202.4c	NFPA 70	National Electrical Code
6.6202.5b	ANSI/ACCA 5 - 2010 QI	HVAC Quality Installation Specification
6.6202.5b	ANSI/ASHRAE Standard 111	Measurement, Testing, Adjusting and Balancing of Building HVAC Systems
6.6202.5b	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings

6.6202.5c	NFPA 70	National Electrical Code
6.6202.6b	ANSI/ACCA 5 - 2010 QI	HVAC Quality Installation Specification
6.6202.6b	ANSI/ASHRAE Standard 111	Measurement, Testing, Adjusting and Balancing of Building HVAC Systems
6.6202.6b	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
6.6202.6c	NFPA 70	National Electrical Code
6.6202.6l	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
6.6202.6q	ASTM C1193 - 09	Standard Guide for Use of Joint Sealants
6.6202.9b	ASHRAE Standard 52.2-2007	Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size
6.6203.1a	ENERGY STAR	General
6.6203.1b	ASHRAE Handbook	Fundamentals
6.6203.1c	2012 IRC	M1401.2
6.6203.2b	ANSI/ACCA 5 - 2010 QI	HVAC Quality Installation Specification
6.6203.2b	ANSI/ASHRAE Standard 111	Measurement, Testing, Adjusting and Balancing of Building HVAC Systems
6.6203.2b	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
6.6203.2b	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
6.6203.2f	NFPA 70	National Electrical Code
6.6203.3a	ENERGY STAR	General
6.6203.3b	ANSI/ACCA 5 - 2010 QI	HVAC Quality Installation Specification
6.6203.3b	ANSI/ASHRAE Standard 111	Measurement, Testing, Adjusting and Balancing of Building HVAC Systems
6.6203.3b	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
6.6203.3b	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
6.6203.3f	NFPA 70	National Electrical Code
6.6207.1b	ANSI/ASHRAE Standard 62.1-2010	Ventilation and Acceptable Indoor Air Quality, Table 5-1
6.6207.1c	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
6.6288.1a	ANSI/ASHRAE 62.2	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
6.6288.1b	ANSI/ASHRAE 62.2	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings

6.9901.1	ANSI/ASHRAE 62.2	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
7.8001.1a	NAECA	National Appliance Energy Conservation Act
7.8001.1b	NFPA 70A	National Electrical Code® Requirements for One- and Two-Family Dwellings
7.8001.2a	FDA Consumer Health Website	Are you storing food safely?
7.8001.3a	NFPA 70	National Electrical Code® Requirements for One- and Two-Family Dwellings, Article 440
7.8001.3b	ENERGY STAR	General
7.8001.3b	NAECA	National Appliance Energy Cnservation Act
7.8001.3c	Federal Fair Housing Act	General
7.8001.3c	ICC/ANSI A117.1	Accessible and Usable Buildings and Facilities
7.8001.3c	NFPA 70	National Electrical Code
7.8001.3f	OSHA 1910	Occupational Safety and Health Standards
7.8002.1a	ENERGY STAR	General
7.8002.1a	NAECA	National Appliance Energy Conservation Act
7.8002.2a	NFPA 70	National Electrical Code, Section 422
7.8002.2b	ENERGY STAR	General
7.8002.2b	NAECA	National Appliance Energy Cnservation Act
7.8002.2e	EPA	Responsible Recycling (R2)
7.8002.2f	OSHA	General
7.8003.10c	NFPA 70	National Electrical Code® Requirements for One- and Two-Family Dwellings
7.8003.10c	NFPA 70E	Standard for Electrical Safety in the Workplace®
7.8003.10e	ANSI/NFPA 101	Building Exit Codes
7.8003.11b	ENERGY STAR	General
7.8003.11b	UL 1570	Fluorescent Lighting Fixtures
7.8003.11b	UL 542	Fluorescent Lamp Starters
7.8003.11c	OSHA 1910	Occupational Safety and Health Standards, Subpart S
7.8003.11d	ANSI/NFPA 101	Building Exit Codes
7.8003.11e	EPA	General
7.8003.11f	EPA	General
7.8003.11g	EPA	Chapter
7.8003.12a	LCA EE110	Lighting Control Association
7.8003.12c	ANSI/NFPA 101	Building Exit Codes
7.8003.12c	IBC - 2009	International Building Code
7.8003.13b	ANSI C82.1	Ballasts - for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type)

7.8003.13b	ANSI/NEMA C82.4	Ballasts for High-Intensity Discharge and Low-Pressure Sodium (LPS) Lamps (Multiple-Supply Type)
7.8003.13b	NEMA	National Electricla Manufacturers Association
7.8003.13b	UL 1029	High-Intensity-Discharge Lamp Ballasts
7.8003.13b	UL 924	Emergency Lighting and Power Equipment
7.8003.13c	NFPA 70E	Standard for Electrical Safety in the Workplace®
7.8003.13c	OSHA 1910	Occupational Safety and Health Standards, Subpart S
7.8003.13d	ANSI/NFPA 101	Building Exit Codes
7.8003.14b	UL 153	Portable Electric Luminaires
7.8003.14b	UL 1598	Luminaires
7.8003.14b	ENERGY STAR	General
7.8003.14c	NFPA 70	National Electrical Code® Requirements for One- and Two-Family Dwellings
7.8003.14c	NFPA 70E	Standard for Electrical Safety in the Workplace®
7.8003.14c	NECA/IESNA 500	General
7.8003.14c	NFPA 101	Life Safety Code
7.8003.14c	OSHA 1910	Occupational Safety and Health Standards, Subpart S
7.8003.14d	ANSI/NFPA 101	Building Exit Codes
7.8003.14f	EPA	General
7.8003.14h	EPA	General
7.8003.15b	UL 1570	Fluorescent Lighting Fixtures
7.8003.15b	UL 542	Fluorescent Lamp Starters
7.8003.15c	NFPA 70E	Standard for Electrical Safety in the Workplace®
7.8003.15c	OSHA 1910	Occupational Safety and Health Standards, Subpart S
7.8003.15f	EPA	General
7.8003.1b	ENERGY STAR	General
7.8003.1b	Environmental Protection Agency	Healthy Indoor Environment Protocols for Home Energy Upgrades
7.8003.1b	NFPA 70	National Electrical Code®
7.8003.2a	IBC - 2009	International Building Code, Section 1011
7.8003.2a	NFPA 101	Life Safety Code
7.8003.2b	IFC	General
7.8003.2b	IBC - 2009	International Building Code
7.8003.2b	NEMA	Premium Exit Sign List
7.8003.2b	NFPA 70	National Electrical Code, Section 700.12 F
7.8003.2b	NFPA 70	National Electrical Code
7.8003.2b	UL 924	Emergency Lighting and Power Equipment

7.8003.2c	NFPA 70E	Standard for Electrical Safety in the Workplace®
7.8003.2c	NFPA 70	National Electrical Code
7.8003.2c	OSHA 1910	Occupational Safety and Health Standards, Subpart S
7.8003.2d	ANSI/NFPA 101	Building Exit Codes
7.8003.2d	NFPA 70	National Electrical Code, Section 700.12 F
7.8003.2e	EPA	General
7.8003.2f	EPA	Chapter
7.8003.3b	NFPA 70	National Electrical Code, Section 700.12 F
7.8003.3b	UL 1570	Fluorescent Lighting Fixtures
7.8003.3b	UL 542	Fluorescent Lamp Starters
7.8003.3c	NFPA 70E	Standard for Electrical Safety in the Workplace®
7.8003.3c	OSHA 1910	Occupational Safety and Health Standards, Subpart S
7.8003.3d	ANSI/NFPA 101	Building Exit Codes
7.8003.3d	NFPA 110	Life Safety Code
7.8003.3d	NFPA 70	National Electrical Code, Section 700.12 F
7.8003.3e	EPA	General
7.8003.3f	EPA	Chapter
7.8003.4c	ANSI/ASHRAE Standard 90.1-2010	Energy Standard for Buildings Except Low-Rise Residential Buildings
7.8003.4c	ANSI/ASHRAE Standard 90.2 - 2007	Energy Efficient Design of Low-Rise Residential Buildings
7.8003.4c	NFPA 101	Life Safety Code
7.8003.4c	NFPA 70	National Electrical Code
7.8003.4e	ANSI/NFPA 101	Building Exit Codes
7.8003.5b	NFPA 70	National Electrical Code® Requirements for One- and Two-Family Dwellings
7.8003.5b	NFPA 70E	Standard for Electrical Safety in the Workplace®
7.8003.5c	ANSI/ASHRAE Standard 90.1-2010	Energy Standard for Buildings Except Low-Rise Residential Buildings
7.8003.5c	ANSI/ASHRAE Standard 90.2 - 2007	Energy Efficient Design of Low-Rise Residential Buildings
7.8003.5c	ANSI/NFPA 101	Building Exit Codes
7.8003.5c	NFPA 70	National Electrical Code® Requirements for One- and Two-Family Dwellings
7.8003.5d	ANSI/NFPA 101	Building Exit Codes
7.8003.6b	UL 60730-1	Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements
7.8003.6c	NFPA 70	National Electrical Code® Requirements for One- and Two-Family Dwellings

7.8003.6c	NFPA 70E	Standard for Electrical Safety in the Workplace®
7.8003.6f	ANSI/NFPA 101	Building Exit Codes
7.8003.7b	UL 917	Clock Operated Switches
7.8003.7c	NFPA 70	National Electrical Code® Requirements for One- and Two-Family Dwellings
7.8003.7c	NFPA 70E	Standard for Electrical Safety in the Workplace®
7.8003.7d	ANSI/ASHRAE Standard 90.1-2010	Energy Standard for Buildings Except Low-Rise Residential Buildings
7.8003.7d	ANSI/ASHRAE Standard 90.2 - 2007	Energy Efficient Design of Low-Rise Residential Buildings
7.8003.7f	ANSI/ASHRAE Standard 90.1-2010	Energy Standard for Buildings Except Low-Rise Residential Buildings
7.8003.7f	ANSI/ASHRAE Standard 90.2 - 2007	Energy Efficient Design of Low-Rise Residential Buildings
7.8003.7f	ANSI/NFPA 101	Building Exit Codes
7.8003.8b	UL 60730-1	Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements
7.8003.8c	NFPA 70	National Electrical Code® Requirements for One- and Two-Family Dwellings
7.8003.8c	NFPA 70E	Standard for Electrical Safety in the Workplace®
7.8003.8f	ANSI/NFPA 101	Building Exit Codes
7.8003.9c	NFPA 70	National Electrical Code® Requirements for One- and Two-Family Dwellings
7.8003.9c	NFPA 70E	Standard for Electrical Safety in the Workplace®
7.8003.9f	ANSI/NFPA 101	Building Exit Codes
7.8004.1a	ENERGY STAR	General
7.8004.1a	NAECA	National Appliance Energy Conservation Act
7.8004.1b	2012 IRC	P2903.9.3
7.8004.1b	2012 IRC	P2903.9.4
7.8004.2a	NAECA	National Appliance Energy Conservation Act
7.8004.3a	NFPA 70	National Electrical Code, Section 422
7.8004.3b	NAECA	National Appliance Energy Cnservation Act
7.8004.3c	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
7.8004.3c	ASTM C1193 - 09	Standard Guide for Use of Joint Sealants
7.8004.3c	ASTM E1998 - 02(2007)	Standard Guide for Assessing Depressurization-Induced Backdrafting and Spillage from Vented Combustion Appliances
7.8004.3c	Federal Fair Housing Act	General

7.8004.3c	ICC/ANSI A117.1	Accessible and Usable Buildings and Facilities
7.8004.3c	NFPA 70	National Electrical Code
7.8004.3f	OSHA	General
7.8004.3h	AHAM	Association of Home Appliance Manufacturers
7.8005.1a	UL 541	Refrigerated Vending Machines
7.8005.1a	ENERGY STAR	General
7.8005.1b	NFPA 70	National Electrical Code® Requirements for One- and Two-Family Dwellings, Article 422.51
7.8005.1b	ICC/ANSI A117.1	Accessible and Usable Buildings and Facilities
7.8005.1c	EPA	40 CFR 82.156
7.8005.2a	UL 751	Vending Machines
7.8005.2b	NFPA 70	National Electrical Code® Requirements for One- and Two-Family Dwellings, Article 422.51
7.8005.2b	ICC/ANSI A117.1	Accessible and Usable Buildings and Facilities
7.8005.2d	ANSI/NFPA 101	Building Exit Codes
7.8005.3a	ENERGY STAR	General
7.8005.3b	ICC/ANSI A117.1	Accessible and Usable Buildings and Facilities
7.8005.3c	Clean Air Act	Section 608
7.8101.4a	NFPA 70	National Electrical Code
7.8101.4b	ENERGY STAR	General
7.8101.4b	NAECA	National Appliance Energy Cnservation Act
7.8101.4b	EPA	WaterSense
7.8101.4c	ASTM C1193 - 09	Standard Guide for Use of Joint Sealants
7.8101.4c	NFPA 70	National Electrical Code
7.8101.4f	OSHA	General
7.8101.5a	NFPA 70	National Electrical Code, Article 422.31
7.8101.5a	NFPA 70	National Electrical Code, Article 422.16
7.8101.5b	ENERGY STAR	General
7.8101.5c	NFPA 70	National Electrical Code® Requirements for One- and Two-Family Dwellings, Article 422.16
7.8101.5c	NFPA 70	National Electrical Code® Requirements for One- and Two-Family Dwellings
7.8101.5c	NFPA 70E	Standard for Electrical Safety in the Workplace®
7.8101.5c	OSHA 1910	Occupational Safety and Health Standards, Subpart S
7.8102.1a	2012 IRC	P2801
7.8102.1b	2012 IRC	Chapter 23
7.8102.2b	2012 IRC	M2201.7
7.8102.2b	2012 IRC	N1102.4.1.1

7.8102.2b	2012 IRC	R105.1
7.8102.2d	2012 IRC	P2801.5
7.8102.2d	2012 IRC	P2801.5.2
7.8102.2f	2012 IRC	P2803
7.8102.2f	2012 IRC	P2803.6.1
7.8102.2g	2012 IRC	G2415.5
7.8102.2g	2012 IRC	G2420.5
7.8102.2g	2012 IRC	G2422.1.4
7.8102.2g	2012 IRC	General
7.8102.2g	2012 IRC	P2905.17
7.8102.2g	2012 IRC	P3003.18.2
7.8102.2i	2012 IRC	N1103.4.2
7.8102.2j	ANSI Z223.1	National Fuel Gas Code
7.8102.2j	NFPA 31	Standard for the Installation of Oil-Burning Equipment
7.8102.2j	NFPA 54	National Fuel Gas Code
7.8102.2j	NFPA 70	National Electrical Code®
7.8102.2m	ANSI/ASHRAE 62.2	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
7.8102.3b	2012 IRC	M2201.7
7.8102.3b	2012 IRC	N1102.4.1.1
7.8102.3b	2012 IRC	R105.1
7.8102.3c	2012 IRC	General
7.8102.3d	2012 IRC	P2801.5
7.8102.3d	2012 IRC	P2801.5.2
7.8102.3e	2012 IRC	P2803
7.8102.3e	2012 IRC	P2803.6.1
7.8102.3f	2012 IRC	G2415.5
7.8102.3f	2012 IRC	G2420.5
7.8102.3f	2012 IRC	G2422.1.4
7.8102.3f	2012 IRC	General
7.8102.3f	2012 IRC	P2905.17
7.8102.3f	2012 IRC	P3003.18.2
7.8102.3h	2012 IRC	N1103.4.2
7.8102.3i	2012 IRC	G2407
7.8102.3i	2012 IRC	G2407.5.1
7.8102.3i	ANSI Z223.1	National Fuel Gas Code
7.8102.3i	NFPA 54	National Fuel Gas Code
7.8102.3j	2012 IRC	Chapter 24
7.8102.3k	BPI-1100-T-2012	Home Energy Auditing Standard
7.8102.3l	2012 IRC	Chapter 24
7.8102.3l	ANSI Z223.1	National Fuel Gas Code
7.8102.3l	NFPA 31	Standard for the Installation of Oil-Burning Equipment
7.8102.3l	NFPA 54	National Fuel Gas Code
7.8102.3l	NFPA 58	Liquefied Petroleum Gas Code
7.8102.3l	NFPA 70	National Electrical Code®

7.8102.3p	ANSI/ASHRAE 62.2	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
7.8102.4b	ASTM C1193 - 09	Standard Guide for Use of Joint Sealants
7.8102.4c	ASTM C1193 - 09	Standard Guide for Use of Joint Sealants
7.8102.4c	NFPA 54/ANSI/AGA Z223.1	National Fuel Gas Code
7.8102.4d	IPC	International Plumbing Code, Section 504.7
7.8102.4d	UPC	Universal Plumbing Code, Section 507.4
7.8102.4f	IPC	International Plumbing Code, Section 504
7.8102.4f	ANSI Z21.22	Relief Valves for Hot Water Supply Systems
7.8102.4g	NFPA 54/ANSI/AGA Z223.1	National Fuel Gas Code
7.8102.4j	IFGC	International Fuel Gas Code
7.8102.4j	NFPA 31	Standard for the Installation of Oil-Burning Equipment
7.8102.4j	NFPA 54/ANSI/AGA Z223.1	National Fuel Gas Code
7.8102.4k	IFGC	International Fuel Gas Code
7.8102.4k	NFPA 31	Standard for the Installation of Oil-Burning Equipment
7.8102.4k	NFPA 54/ANSI/AGA Z223.1	National Fuel Gas Code
7.8102.4l	ASTM E1998 - 02(2007)	Standard Guide for Assessing Depressurization-Induced Backdrafting and Spillage from Vented Combustion Appliances
7.8102.4m	NFPA 31	Standard for the Installation of Oil-Burning Equipment
7.8102.4m	NFPA 54/ANSI/AGA Z223.1	National Fuel Gas Code
7.8102.4m	NFPA 70	National Electrical Code
7.8102.4o	NFPA 31	Standard for the Installation of Oil-Burning Equipment
7.8102.4o	NFPA 54/ANSI/AGA Z223.1	National Fuel Gas Code
7.8102.4o	NFPA 70A	National Electrical Code® Requirements for One- and Two-Family Dwellings
7.8102.4p	NFPA 720	Standard for the Installation of Carbon Monoxide Detection and Warning Equipment
7.8102.4q	ANSI/ASHRAE Standard 62.2-2010	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
7.8102.5b	ASTM C1193 - 09	Standard Guide for Use of Joint Sealants
7.8102.5c	NFPA 31	Standard for the Installation of Oil-Burning Equipment
7.8102.5c	NFPA 70A	National Electrical Code® Requirements for One- and Two-Family Dwellings
7.8102.5d	IPC	International Plumbing Code, Section 504.7
7.8102.5d	UPC	Universal Plumbing Code, Section 507.4

7.8102.5e	IPC	International Plumbing Code, Section 504
7.8102.5e	ANSI Z21.22	Relief Valves for Hot Water Supply Systems
7.8102.5f	NFPA 70A	National Electrical Code® Requirements for One- and Two-Family Dwellings
7.8102.5g	NFPA 70	National Electrical Code
7.8102.5i	NFPA 54/ANSI/AGA Z223.1	National Fuel Gas Code
7.8102.5j	ANSI/ASHRAE Standard 90.1-2010	Energy Standard for Buildings Except Low-Rise Residential Buildings
7.8102.5j	IECC	International Energy Conservation Code
7.8102.5k	ANSI/ASHRAE Standard 90.2 - 2007	Energy Efficient Design of Low-Rise Residential Buildings
7.8102.5k	IFGC	International Fuel Gas Code
7.8102.5k	NFPA 31	Standard for the Installation of Oil-Burning Equipment
7.8102.5k	NFPA 54/ANSI/AGA Z223.1	National Fuel Gas Code
7.8102.5l	IFGC	International Fuel Gas Code
7.8102.5l	NFPA 31	Standard for the Installation of Oil-Burning Equipment
7.8102.5l	NFPA 54/ANSI/AGA Z223.1	National Fuel Gas Code
7.8102.5m	ASTM E1998 - 02(2007)	Standard Guide for Assessing Depressurization-Induced Backdrafting and Spillage from Vented Combustion Appliances
7.8102.5n	NFPA 31	Standard for the Installation of Oil-Burning Equipment
7.8102.5n	NFPA 54/ANSI/AGA Z223.1	National Fuel Gas Code
7.8102.5n	NFPA 70	National Electrical Code
7.8102.5o	NFPA 31	Standard for the Installation of Oil-Burning Equipment
7.8102.5o	NFPA 54/ANSI/AGA Z223.1	National Fuel Gas Code
7.8102.5o	NFPA 70A	National Electrical Code® Requirements for One- and Two-Family Dwellings
7.8102.5q	ANSI/ASHRAE Standard 62.1-2010	Ventilation and Acceptable Indoor Air Quality
7.8102.5q	NFPA 720	Standard for the Installation of Carbon Monoxide Detection and Warning Equipment
7.8102.6e	IPC	International Plumbing Code, Section 504
7.8102.6e	ANSI Z21.22	Relief Valves for Hot Water Supply Systems
7.8102.6e	UPC	Universal Plumbing Code
7.8102.6g	NFPA 70	National Electrical Code
7.8102.6h	ANSI/ASHRAE Standard 90.1-2010	Energy Standard for Buildings Except Low-Rise Residential Buildings
7.8102.6h	IECC	International Energy Conservation Code
7.8102.6i	NFPA 70	National Electrical Code

7.8102.6k	NFPA 31	Standard for the Installation of Oil-Burning Equipment
7.8102.6k	NFPA 54/ANSI/AGA Z223.1	National Fuel Gas Code
7.8102.6k	NFPA 70A	National Electrical Code® Requirements for One- and Two-Family Dwellings
7.8102.7h	IPC	International Plumbing Code, Section 504.7
7.8102.7h	UPC	Universal Plumbing Code, Section 507.4
7.8102.7i	NFPA 54/ANSI/AGA Z223.1	National Fuel Gas Code
7.8102.7i	UPC	Universal Plumbing Code
7.8102.7k	NFPA 70	National Electrical Code
7.8102.7m	ANSI/ASHRAE Standard 90.1-2010	Energy Standard for Buildings Except Low-Rise Residential Buildings
7.8102.7m	IECC	International Energy Conservation Code
7.8102.7o	NFPA 70	National Electrical Code
7.8102.8b	ASTM C1193 - 09	Standard Guide for Use of Joint Sealants
7.8102.8e	NFPA 31	Standard for the Installation of Oil-Burning Equipment
7.8102.8e	NFPA 54/ANSI/AGA Z223.1	National Fuel Gas Code
7.8102.8e	NFPA 70A	National Electrical Code® Requirements for One- and Two-Family Dwellings
7.8102.8f	IRC	International Residential Code, Section 20801.5.1
7.8102.8f	UPC	Universal Plumbing Code, Section 5.10.7
7.8102.8g	IPC	International Plumbing Code, Section 504
7.8102.8g	ANSI Z21.22	Relief Valves for Hot Water Supply Systems
7.8102.8g	UPC	Universal Plumbing Code
7.8102.8h	IPC	International Plumbing Code, Section 504.7
7.8102.8h	UPC	Universal Plumbing Code, Section 507.4
7.8102.8i	NFPA 70	National Electrical Code
7.8102.8l	ANSI/ASHRAE Standard 90.1-2010	Energy Standard for Buildings Except Low-Rise Residential Buildings
7.8102.8l	IECC	International Energy Conservation Code
7.8102.8n	NFPA 70	National Electrical Code
7.8102.9b	ASTM C1193 - 09	Standard Guide for Use of Joint Sealants
7.8102.9f	NFPA 31	Standard for the Installation of Oil-Burning Equipment
7.8102.9f	NFPA 54/ANSI/AGA Z223.1	National Fuel Gas Code
7.8102.9f	NFPA 70A	National Electrical Code® Requirements for One- and Two-Family Dwellings
7.8102.9g	IPC	International Plumbing Code, Section 504.7
7.8102.9g	UPC	Universal Plumbing Code, Section 507.4
7.8102.9h	IPC	International Plumbing Code, Section 504

7.8102.9h	ANSI Z21.22	Relief Valves for Hot Water Supply Systems
7.8102.9h	UPC	Universal Plumbing Code
7.8102.9j	NFPA 70	National Electrical Code
7.8102.9k	ANSI/ASHRAE Standard 90.1-2010	Energy Standard for Buildings Except Low-Rise Residential Buildings
7.8102.9k	IECC	International Energy Conservation Code
7.8102.9l	NFPA 70	National Electrical Code
7.8103.1a	NFPA 70	National Electrical Code®
7.8103.1b	2012 IRC	General
7.8103.1c	2012 IRC	N1103.4.2
7.8103.1e	2012 IRC	P2803
7.8103.1e	2012 IRC	P2803.6.1
7.8103.1g	ANSI/ASHRAE 62.2	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
7.8103.2a	NFPA 70	National Electrical Code®
7.8103.2b	2012 IRC	General
7.8103.2c	2012 IRC	P2803
7.8103.2c	2012 IRC	P2803.6.1
7.8103.2c	ANSI Z223.1	National Fuel Gas Code
7.8103.2c	NFPA 54	National Fuel Gas Code
7.8103.2d	BPI-1100-T-2012	Home Energy Auditing Standard
7.8103.2e	2012 IRC	G2407
7.8103.2e	2012 IRC	G2407.5.1
7.8103.2f	IFGC	International Fuel Gas Code
7.8103.2f	NFPA 31	Standard for the Installation of Oil-Burning Equipment
7.8103.2f	NFPA 54	National Fuel Gas Code
7.8103.2f	NFPA 58	Liquefied Petroleum Gas Code
7.8103.2g	NFPA 70	National Electrical Code®
7.8103.5c	CSA	B483.1
7.8103.5c	NSF 42	Drinking Water Treatment Units - Aesthetic Effects
7.8103.5c	NSF 42	Drinking Water Treatment Units - Aesthetic Effects
7.8103.5c	NSF 53	Drinking Water Treatment Units - Health Effects
7.8103.5c	NSF 62	Drinking Water Distillation Systems
7.8103.5e	NFPA 70	National Electrical Code
7.8103.5h	NACE TPC 7	National Association of Corrosion Engineers
7.8103.5h	NACE	National Association of Corrosion Engineers
7.8104.1c	ASSE 1017	Temperature Actuated Mixing Valves for hot Water Distribution Systems
7.8104.1c	ASSE 1069	Performance Requirements for Automatic Temperature Control Mixing Valves

7.8104.1c	ASSE 1070	Performance Requirements for Water Temperature Limiting Devices
7.8104.3d	ANSI/ASHRAE Standard 90.1-2010	Energy Standard for Buildings Except Low-Rise Residential Buildings
7.8104.3d	IECC	International Energy Conservation Code
7.8104.3h	NFPA 70	National Electrical Code
7.8104.4n	NFPA 70	National Electrical Code
7.8801.1c	NFPA 70	National Electrical Code® Requirements for One- and Two-Family Dwellings, Article 620
7.8801.1c	ASME A17.1	Safety Code for Elevators and Escalators
7.8801.1c	ICC/ANSI A117.1	Accessible and Usable Buildings and Facilities
7.8802.1b	APSP-15	Standard for Energy Efficiency for Residential Inground Swimming Pools and Spas
7.8802.1c	NFPA 70	National Electrical Code® Requirements for One- and Two-Family Dwellings, Article 680
7.8802.1c	NFPA 70E	Standard for Electrical Safety in the Workplace®
7.8802.1c	OSHA 1910	Occupational Safety and Health Standards, Subpart S

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SPECIFICATION	STANDARD REFERENCE	SECTION
2.0111.2A	**2012 IRC**	**GENERAL**
2.0111.2d	2012 IRC	General
2.0111.2e	2012 IRC	General
2.0111.2f	2012 IRC	General
2.0111.2g	2012 IRC	General
2.0111.3a	2012 IRC	R408.5
2.0201.1b	2012 IRC	G2417.1.2
2.0201.2a	2012 IRC	Chapter 24
2.0201.2a	2012 IRC	General
2.0201.2b	2012 IRC	G2427.8
2.0201.2c	2012 IRC	R315.3
2.0203.1a	2012 IRC	G2407.5.1
2.0203.1b	2012 IRC	G2407
2.0203.2b	2012 IRC	G2425
2.0203.2b	2012 IRC	General
2.0203.2d	2012 IRC	G2407.5.1
2.0203.2e	2012 IRC	G2407
2.0301.1a	2012 IRC	General
2.0301.1a	2012 IRC	R314
2.0301.1b	2012 IRC	General
2.0301.1b	2012 IRC	R314

2.0301.2a	2012 IRC	General
2.0301.2a	2012 IRC	R315
2.0301.2b	2012 IRC	General
2.0301.2b	2012 IRC	R315
2.0401.1b	2012 IRC	R408.1
2.0401.1b	2012 IRC	R408.2
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General Information on Spray Polyurethane Foam (SPF)

Low-Pressure SPF

Low-pressure *SPF* systems are two-component polyurethane foam products. They are typically delivered to the job site in pressurized canisters (~250 *psi*), dispensed though unheated hoses through a disposable mixing nozzle system, and applied as a froth-like material to substrate. This type of *SPF* product is typically used for large sealing and small-scale insulation products.

High-Pressure SPF

High-pressure *SPF* systems are two-component polyurethane foam products. They are typically delivered to the job site in unpressurized drums or totes and dispensed by a proportioner pump where heat and pressure are added. These chemicals travel through heated hoses to a spray gun where the material is aerosolized during application. This type of *SPF* product is typically used for larger insulation applications.

Note on *SPF* Delivery Methods

Once installed, there is essentially no difference in product performance between low- and high-pressure foams. It should be noted that the main differences between the delivery methods are in capital equipment investment, application rate, and *PPE* requirements.

Installer Training

Applicators should obtain training from the suppliers of *SPF* to help assure installation quality and use of all equipment as well as safe handling, use, and disposal of all chemicals used in the process. Spray Polyurethane Foam Alliance (*SPFA*) also offers additional training and accreditation for high-pressure *SPF* applicators.

Manufacturer Installation Instructions

SPF applicators should follow all manufacturer installation instructions for the product being used. These instructions include product-specific documents such as application instructions, MSDSs, and evaluation reports.

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