Guidelines for Home Energy Professionals

Standard Work Specifications for Single-Family Home Energy Upgrades

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Overview

The U.S. Department of Energy's (DOE) Weatherization Assistance Program (WAP) and the National Renewable Energy Laboratory (NREL) developed the Guidelines for Home Energy Professionals project (hereafter Guidelines) to support and promote high quality work within the WAP. NREL is a national laboratory of the DOE, Office of Energy Efficiency & Renewable Energy (EERE), operated by the Alliance for Sustainable Energy, LLC. EERE sponsored, funded, and provided oversight of the Guidelines project. The Guidelines are also a resource for workers, contractors, training providers, homeowners, and program administrators involved in the broader home performance industry where a comprehensive, whole-house approach to building science is required.

The Guidelines project is about achieving quality in any given home energy upgrade task. To do that, the Guidelines take a three-pronged approach:

1. ***Define the Work through Standard Work Specifications.***
   The Standard Work Specifications (SWS) for Single-Family, Multifamily, and Manufactured Housing Energy Upgrades define the minimum acceptable outcomes for any weatherization or home performance task to be effective, durable, and safe.

2. ***Validate the Training through Job Task Analyses.***
   Job Task Analyses (JTAs) for the four major energy upgrade job classifications define what a worker needs to know and do to be successful. These JTAs cover job tasks for retrofit installer/technician, crew leader, energy auditor, and quality control inspector. The accreditation of energy efficiency training programs verifies that organizations training workers in the industry are qualified to teach to the JTAs.

3. ***Certify the Worker through the Certification Blueprints.***
   The Certification Blueprints synthesize SWS content and the JTAs to lay out a roadmap for developing robust worker certifications. The four Home Energy Professional worker certifications are part of and are aligned with the Guidelines efforts and target a worker's capacity to demonstrate practical ability to perform the work of the industry.

The Guidelines project allows industry to leverage these three components to develop SWS-based training resources, quality assurance protocols, accredited training programs, and professional certifications. These tools will facilitate the development of a highly qualified work force, demonstrate worker qualifications to employers and homeowners, and enable the industry to validate the quality of its work.

Background

The Guidelines project is supported by the WAP's National Training and Technical Assistance Plan, which supports the high-quality work performed in the WAP through the development of technical tools and resources built upon the WAP's more than 30 years of leadership in home energy upgrade work. The SWS were developed in response to a need identified by WAP technicians and program administrators for a document that would define the technical requirements of the work performed by the program.

The Guidelines development process has involved participation by numerous stakeholders, including WAP technicians and trainers, home performance contractors, building scientists, organized labor, and other professionals throughout the home energy upgrade industry. In addition to the involvement of residential energy efficiency professionals, staff from the Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), and the National Institute for Occupational Safety and Health (NIOSH) participated in writing and reviewing the Guidelines to cover worker and occupant health and safety. The Department of Housing and Urban Development (HUD), Department of Agriculture (USDA), and the Department of Labor (DOL) have also been key partners in the development of the Guidelines.

This document is being disseminated by the DOE. As such, the document was prepared in compliance with Section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001 (Public Law 106-554) and information quality guidelines issued by the DOE. Should this document constitute "influential" information, as that term is defined in the DOE's information quality guidelines or the Office of Management and Budget's Information Quality Bulletin for Peer Review (Bulletin), the document meets the prior peer review pursuant to Section II.2 of the Bulletin. Additionally, the document was reviewed both internally and externally prior to publication. For purposes of external review, the document benefited from review through the public comment process.

Glossary

AAMA	American Architectural Manufacturers Association, *www.aamanet.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
Dual Cooling Up-Duct	Piece of duct located between the living space and attic to allow air flow in pressurized homes having evaporative coolers
EERE	Office of Energy Efficiency and Renewable Energy (DOE)
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
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
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
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
U.S.	United States
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 1: Using the Standard Work Specifications for Single-Family Energy Upgrades

The SWS synthesize more than 30 years of building science expertise within the WAP program and the greater industry by identifying the desired outcomes of the individual measures performed during a whole-house energy upgrade. They combine original content with references to relevant codes and/or technical standards that currently exist as independent, stand-alone documents.

The Whole-House Assessment

The home assessment/energy audit is a vital component of the home energy retrofit process. It is imperative that an assessment of the home is performed by a qualified auditor who is following a high-quality audit procedure recognized by the WAP or other program sponsor. Once the auditor has conducted a whole-house assessment and developed a list of recommended measures, the SWS can be used to identify the desired outcomes of those measures and to assess the quality of the completed work.

The Components of the SWS

The SWS identify the desired outcomes of a particular energy efficiency measure. They define the outcomes, stated as objectives, and then list the minimum specifications that are necessary for a properly installed measure to meet those outcomes (see sample specification).

Sample Specification

4.1006.1 Pull-Down Stairs
Topic: Attics
Subtopic: Attic Openings
4.1006.1 Detail Name: Pull-Down Stairs
Desired Outcome: Pull-down attic stair properly sealed and insulated

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1006.1a	Installation	Hatches will be insulated with non-compressible insulation and the measure will include a protective barrier or baffle Pull-down stair assembly will be insulated to the same R-value as the adjoining insulated assembly Pull-down stair rough opening will be surrounded with a durable dam that is higher than the level of the attic floor insulation	Achieve uniform R-value Prevent loose insulation from entering the living area

The ***Specification*** defines the minimum level of action required to meet the ***Objective***.

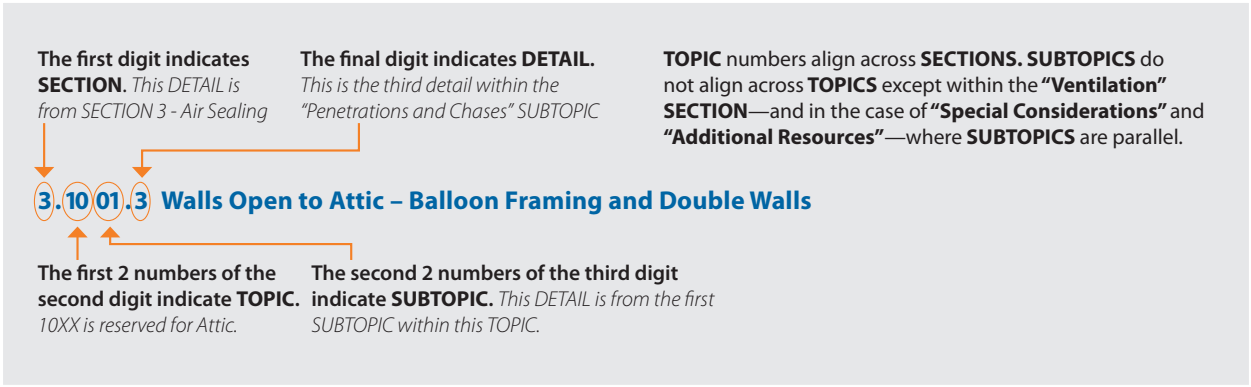
The ***Objective*** defines the required outcomes of the work.

SWS Numbering Scheme

The details within the SWS have been indexed and numbered in a way that provides readers with suggestions as to what is contained in a specific detail, and allows for additions as the document expands without disrupting the numbering sequence. The SWS are organized into

four layers. From general to specific, those layers are section, topic, subtopic, and detail. Each section contains multiple topics, each topic may be further divided into subtopics, and each subtopic contains one or more details.

Dissecting a Detail Number



There are seven sections in the SWS:

1. Using the Standard Work Specifications for Single-Family Energy Upgrades
2. Health and Safety
3. Air Sealing
4. Insulation
5. Heating and Cooling
6. Ventilation
7. Baseload

The section number is the first digit of a given detail. As illustrated above, any detail number beginning with 3 is from Section 3—Air Sealing.

Within each section, another set of numbers has been assigned to topics. These are represented in the first two digits in the second number in the detail titles. Some numbers are not yet in use but are reserved for future expansion of the SWS. In the example shown above, .10XX indicates that the detail is in the topic "Attics." A detail related to insulating attics would be 4.10XX.X. For example, 4.1001.4 Vented Eave or Soffit Baffles.

Here is a full list of topic designations:

.0100 - .0900 – Health and Safety Issues

.0100 Safe Work Practices
.0200 Combustion Safety
.0300 Safety Devices
.0400 Moisture

.0500 Radon
.0600 Electrical
.0700 Occupant Education and Access
.0800 and .0900 Reserved for Future Additions

.1000 - .2900 – Parts of the Building

.1000 Attics
.1100 Walls
.1200 Windows and Doors
.1300 Floors
.1400 Basements and Crawl Spaces
.1500 Attached Garages
.1600 Ducts
.1700+ Reserved for Future Additions

.3000 - .5900 – Heating and Cooling Systems

.3000 Forced Air
.3100 Hydronic Heating
.3200 Shading
.3300+ Reserved for Future Additions

.6000 - .7900 – Ventilation

.6000 Exhaust
.6100 Supply
.6200 Whole Building
.6300+ Reserved for Future Additions

.8000 - .9800 – Baseload

.8000 Plug Load
.8100 Water Heating
.8200+ Reserved for Future Additions

These topic numbers align across sections.

Additionally, these number pairs have been reserved to align across sections and topics.

.88 Special Considerations

.99 Additional Resources

Used at the topic level, it looks like this:

6.9901.1 Supplemental Ventilation Information - ASHRAE 62.2

This is the first detail in Section 6—Ventilation, topic .99 Additional Resources, subtopic 01 Codes and Standards Resources.

Used at the subtopic level, it looks like this:

6.6288.1 Sound Rating Limits

This is the first detail in Section 6—Ventilation, topic .62 Whole Building, subtopic 88 Special Considerations.

Codes and Standards

While the SWS will help identify the desired outcomes of energy efficiency measures in a weatherization or home energy upgrade project, they are not a replacement for the codes and/or technical standards mandated by a particular jurisdiction. State, local, or municipal code or ordinance has legal precedence and users should obtain copies of the applicable codes and standards for their jurisdiction before performing the work.[1]

Numerous national standards bodies have provided significant insight and input on the SWS. The 2012 International Residential Code (IRC) for One- and Two-Family Dwellings serves as the primary referenced standard. In order to limit redundancy, standards that are already referenced within the 2012 IRC are not restated within the Guidelines. However, when a standard is not addressed by the 2012 IRC, it is referenced within the Referenced Standards as an additional resource. It is important to note that references to codes and standards within the SWS documents do not constitute an endorsement by the WAP.

Standards are referenced in two ways:

1. Embedded in the specification in either the objective or specification column. This indicates that the referenced standard is a representative approach to meet the specification.
2. Listed in Appendix C: Guide to Referenced Standards.

Appendix C: Guide to Referenced Standards lists the codes, standards, and other technical publications that support the SWS. The Appendix can be used in one of 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.

1 References to codes/standards in the SWS do not constitute an endorsement.

The EPA Healthy Indoor Environment Protocols for Home Energy Upgrades

DOE and the EPA have collaborated closely throughout the production of the Guidelines and EPA's Healthy Indoor Environment Protocols for Home Energy Upgrades. In particular, the two agencies have strived to ensure that the majority of the EPA minimum actions are fundamentally integrated and referenced as appropriate in the Standard Work Specifications for Single-Family Energy Upgrades. The intent is that upgrade workers following the DOE document will inherently achieve most of the EPA minimum recommendations.

The EPA protocols can be located at: www.epa.gov/iaq/homes/retrofits.html and should be referenced and utilized by energy upgrade workers.

The EPA protocols also provide additional detailed information on healthy retrofit practices and address some situations not specifically covered in the SWS including, below-ground contaminants from sewer gases and soil or groundwater contamination, building products/materials emissions, and removal of fluorescent light ballasts containing polychlorinated biphenyls (PCBs). Additionally, both DOE and the EPA fully support the upgrade industry going above and beyond the minimum requirements by adopting the EPA-recommended expanded actions. Both agencies also understand that financial or programmatic constraints may impede this in certain cases.[2]

The EPA Healthy Indoor Environment Protocols for Home Energy Upgrades focuses primarily on the health and safety of the building occupants. The EPA document includes recommended assessment protocols to identify indoor environmental quality issues, recommended minimum actions, and opportunities for expanded actions to promote improved occupant health through home energy upgrades. Each of these is described below.

- ***Assessment protocols*** provide EPA-recommended protocols for evaluating both existing conditions of concern and the potential for additional health concerns that may arise as a result of upgrade activities.
- ***Minimum actions*** include actions that weatherization and home energy upgrade contractors should take to help ensure that the work they perform in a home does not introduce new health concerns or make existing conditions worse. These often reference existing national standards; however, work should be conducted in compliance with state and local requirements as well.
- ***Expanded actions*** include recommended further indoor environment improvements that can be made during many home energy upgrade projects. The expanded actions are improvements that can be performed by home energy upgrade workers with proper training and sufficient resources. National standards and guidance are referenced; however, work should be conducted in compliance with state and local requirements as well.

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2 Weatherization Program Notice 11-6 provides information related to the implementation and installation of health and safety measures as part of the WAP. This guidance makes available recommendations to WAP Grantees as they develop their Health and Safety (H&S) Plans and procedures. The guidance also provides clarity to grantees on H&S measures and costs that are allowed as part of this energy program. WPN 11-6 (Program Year 2011, the "dash 6" will be the reference for subsequent H&S guidance in future program years) is available at www.waptac.org under rules and guidance.

The Importance of Qualified Professionals

It is important for the user to understand the necessity of ensuring that all contractors undertaking the work outlined in the SWS are properly qualified. There are a number of certification bodies and industry groups that provide verification of an individual's qualifications to perform certain types of work. This is particularly important in tasks related to heating, ventilating, and air conditioning (HVAC), electrical systems, and plumbing. Professional contractors who are credentialed through well-established national organizations can help ensure that this work is performed safely and correctly. There are often licensure requirements at the state or local level.

Within the SWS, there is a note placed in each detail in which a licensed or credentialed professional may be required to perform certain tasks. The reader is encouraged to ensure that all work is carried out in accordance with requirements set forth by the authority having jurisdiction.

The WAP requires its contractors to adhere to all codes, licensing, and certification requirements in the jurisdiction in which they operate.

Section 2: Health and Safety

2.0100.1 Global Worker Safety

Topic: Safe Work Practices
Subtopic: Safe Work Practices
2.0100.1 Detail Name: Global Worker Safety
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 reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
2.0100.1a	Prevention through design	Design will be incorporated to eliminate or minimize hazards (e.g., material selection, access to equipment for installation and maintenance, placement of equipment, ductwork and condensate lines)	Prevent worker injuries Reduce risk exposure to toxic substances and physical hazards
2.0100.1b	Hand protection	Durable and wrist-protecting gloves will be worn that can withstand work activity	Minimize skin contact with contaminants Protect hands from sharp objects
2.0100.1c	Respiratory protection	If the risk of airborne contaminants cannot be prevented, proper respiratory protection will be provided and worn (e.g., N-95 or equivalent face mask) When applying low pressure 2-component spray polyurethane foam, air purifying masks with an organic vapor cartridge and P-100 particulate filter will be used When applying high-pressure SPF insulation, supplied air respirators (SARs) will be used Consult MSDSs for respiratory protection requirements	Minimize exposure to airborne contaminants (e.g., insulation materials, mold spores, feces, bacteria, chemicals)
2.0100.1d	Electrical safety	An electrical safety assessment will be performed All electric tools will be protected by ground-fault circuit interrupters (GFCI) Three-wire type extension cords will be used with portable electric tools Worn or frayed electrical cords will not be used Water sources (e.g., condensate pans) and electrical sources will be kept separate Metal ladders will be avoided Special precautions will be taken if knob and tube wiring is present Aluminum foil products will be kept away from live wires For arc flash hazards, NFPA 70E will be consulted	Avoid electrical shock and arc flash hazards
2.0100.1e	Carbon monoxide (CO)	All homes will have a carbon monoxide alarm Ambient CO will be monitored during combustion testing and testing will be discontinued if ambient CO level inside the home or work space exceeds 35 parts per million (ppm)	Protect worker and occupant health
2.0100.1f	Protective clothing	MSDSs and OSHA regulations will be consulted for protective clothing and equipment Eye protection will always be worn (e.g., safety glasses, goggles if not using full-face respirator)	Protect worker from skin contact with contaminants Minimize spread of contaminants
2.0100.1g	Confined space safety	Access and egress points will be located before beginning work Inspection will be conducted for frayed electrical wires Adequate ventilation will be provided Use of toxic material will be reduced	Prevent build-up of toxic or flammable contaminants Provide adequate access and egress points Prevent electrical shock

2.0100.1h	Power tool safety	Power tools will be inspected and used in accordance with manufacturer specifications to eliminate hazards associated with missing ground prongs, ungrounded circuits, misuse of power tools, noise, and improper or defective cords or extension cords All devices used will be verified as GFCI protected or double insulated Exhaust gases from compressors and generators will be prevented from entering interior space	Prevent power tool injuries
2.0100.1i	Chemical safety	Hazardous materials will be handled in accordance with manufacturer specifications or MSDS standards to eliminate hazards associated with volatile 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
2.0100.1j	Ergonomic safety	Appropriate PPE will be used (e.g., knee pads, bump caps, additional padding) Proper equipment will be used for work Proper lifting techniques will be used	Prevent injuries from awkward postures, repetitive motions, and improper lifting
2.0100.1k	Hand tool safety	Hand tools will be used for intended purpose	Prevent hand tool injuries
2.0100.1l	Slips, trips, and falls	Caution will be used around power cords, hoses, tarps, and plastic sheeting Precautions will be taken when ladders are used, when working at heights, or when balancing on joists Walk boards will be used when practical Appropriate footwear and clothing will be worn	Prevent injuries due to slips, trips, and falls
2.0100.1m	Heat and thermal stress	Appropriate ventilation, hydration, rest breaks, and cooling equipment will be provided 911 will be dialed when necessary	Prevent heat stroke, heat stress, and cold stress related injuries
2.0100.1n	Fire safety	Ignition sources will be identified and eliminated (e.g., turn off pilot lights and fuel supply) Use of flammable material will be reduced and fire-rated materials will be used	Prevent a fire hazard
2.0100.1o	Asbestos-containing materials (ACM)	Assess potential asbestos hazard; if unsure whether material contains asbestos, contact a qualified asbestos professional to assess the material and to sample and test as needed If suspected ACM is in good condition, do not disturb If suspected ACM is damaged (e.g., unraveling, frayed, breaking apart), immediately isolate the area(s) For suspected ACM that is damaged or that must be disturbed as part of the retrofit activity, contact an asbestos professional for abatement or repair in accordance with federal, state, and local requirements; only a licensed or 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
2.0100.1p	Lead paint assessment	Presence of lead based paint in pre-1978 homes will be assumed unless testing confirms otherwise The Environmental Protection Agency (EPA) Renovation, Repair, and Painting (RRP) Program Rule (40 CFR Part 745) in pre-1978 homes and proposed changes to this rule (Federal Register/Vol. 75, No. 87/May 6, 2010) will be complied with, to be superseded by any subsequent final rulemaking or any more stringent state or federal standards; see http:// www.epa.gov/lead/pubs/renovation.htm	Protect workers and occupants from potential lead hazards

2.0103.1 Air Sealing Worker Safety

Topic: Safe Work Practices
Subtopic: Air Sealing
2.0103.1 Detail Name: Air Sealing Worker Safety
Desired Outcome: Work completed safely without injury or hazardous exposure

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
2.0103.1a	Worker safety	All worker safety specifications in Global Worker Safety section will be followed	Prevent injury Minimize exposure to health and safety hazards

2.0104.1 Insulation Worker Safety

Topic: Safe Work Practices
Subtopic: Insulation
2.0104.1 Detail Name: Insulation Worker Safety
Desired Outcome: Work is completed safely without injury or hazardous exposure

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
2.0104.1a	Worker safety	Follow all worker safety specifications in Global Worker Safety section	Prevent injury Minimize exposure to health and safety hazards
2.0104.1b	Vermiculite	OSHA asbestos abatement protocol 29 CFR 1926.1101 will be followed if vermiculite insulation is present If unsure whether material contains asbestos, a qualified asbestos professional will be contacted to assess the material and to sample and test as needed When working around asbestos-containing material (ACM), the following will not be done: • Dust, sweep, or vacuum debris • Saw, sand, scrape, or drill holes in the material • Use abrasive pads or brushes to strip materials Attic insulation that looks like vermiculite (as opposed to fiberglass, cellulose, or urethane foams) will not be removed or disturbed	Protect workers from toxic exposure
2.0104.1c	Respiratory protection	All materials will be handled in accordance with manufacturer specifications or Material Safety Data Sheet (MSDS) standards to eliminate hazards associated with incorrect, defective, or improperly used respirator and personal protective equipment (PPE)	Protect workers from toxic exposure
2.0104.1d	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 rulemaking or any more stringent state or federal standards	Protect worker and occupant from potential lead hazards

2.0105.1 Combustion Worker Safety

Topic: Safe Work Practices
Subtopic: Heating and Cooling Equipment
2.0105.1 Detail Name: Combustion Worker Safety
Desired Outcome: Work completed safely without injury or hazardous exposure

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
2.0105.1a	Worker safety	All worker safety specifications in Global Worker Safety section will be followed	Prevent injury Minimize exposure to health and safety hazards
2.0105.1b	Carbon monoxide (CO)	Ambient CO will be monitored during combustion testing and testing will be discontinued if ambient CO level inside the home or work space exceeds 35 parts per million (ppm)	Protect worker and occupant health
2.0105.1c	Raw fuel	Raw fuel leaks will be monitored for before entering building spaces If leaks are found, testing will be discontinued and condition reported to occupant immediately	Protect worker and occupant health

2.0105.2 Heating and Cooling Worker Safety

Topic: Safe Work Practices
Subtopic: Heating and Cooling Equipment
2.0105.2 Detail Name: Heating and Cooling Worker Safety
Desired Outcome: Work completed safely without injury or hazardous exposure

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
2.0105.2a	Worker safety	Follow all worker safety specifications in Global Worker Safety section	Prevent injury Minimize exposure to health and safety hazards
2.0105.2b	Mercury	Identify and dispose of any mercury containing thermostats in accordance with Environmental Protection Agency (EPA) guidance	Protect workers and occupants from mercury exposure
2.0105.2c	Asbestos	Identify asbestos hazards in boiler and pipe insulation and remediate in accordance with EPA guidelines	Protect workers and occupants from asbestos exposure
2.0105.2d	Protective clothing	Long sleeves and long pants should be worn as additional protection from liquid refrigerants and other skin hazards	Protect worker from skin contact with liquid nitrogen

2.0106.1 Ventilation Worker Safety

Topic: Safe Work Practices
Subtopic: Ventilation Equipment
2.0106.1 Detail Name: Ventilation Worker Safety
Desired Outcome: Work completed safely without injury or hazardous exposure

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
2.0106.1a	Worker safety	Follow all worker safety specifications in Global Worker Safety section	Prevent injury Minimize exposure to health and safety hazards

2.0107.1 Baseload Worker Safety

Topic: Safe Work Practices
Subtopic: Baseload
2.0107.1 Detail Name: Baseload Worker Safety
Desired Outcome: Work is completed safely without injury or hazardous exposure

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
2.0107.1a	Worker safety	All worker safety specifications in Global Worker Safety section will be followed	Prevent injury Minimize exposure to health and safety hazards

2.0110.1 Material Selection, Labeling, and Material Safety Data Sheets (MSDSs)

Topic: Safe Work Practices
Subtopic: Material Safety
2.0110.1 Detail Name: Material Selection, Labeling, and Material Safety Data Sheets (MSDSs)
Desired Outcome: Occupant and worker risk from hazardous materials minimized

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
2.0110.1a	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
2.0110.1b	Material labels	Manufacturer specifications will be followed	Reduce risk of exposure to harmful substances Follow safety procedures
2.0110.1c	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

2.0111.1 Basements and Crawl Spaces Worker Safety

Topic: Safe Work Practices
Subtopic: Basements and Crawl Spaces
2.0111.1 Detail Name: Basements and Crawl Spaces Worker Safety
Desired Outcome: Work completed safely without injury or hazardous exposure

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
2.0111.1a	Worker safety	All worker safety specifications in Global Worker Safety section will be followed	Prevent injury Minimize exposure to health and safety hazards

2.0111.2 Crawl Spaces—Pre-Work Qualifications

Topic: Safe Work Practices
Subtopic: Basements and Crawl Spaces
2.0111.2 Detail Name: Crawl Space—Pre-Work Qualifications
Desired Outcome: Site properly prepared for upgrade

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
2.0111.2a	Fuel leaks	Fuel leaks will be repaired and inspected in accordance with the 2012 IRC	Ensure site is safe and ready for upgrade
2.0111.2b	Electrical hazards	Electrical hazards will be eliminated and inspected in accordance with NFPA 70 National Electric Code	Ensure site is safe and ready for upgrade
2.0111.2c	Mold	Appropriate remediation will be completed before upgrade	Ensure site is safe and ready for upgrade
2.0111.2d	Plumbing and water leaks	Plumbing leaks will be repaired before crawl space upgrade in accordance with the 2012 IRC	Prepare site for upgrade
2.0111.2e	Pest and termite work	Pest and termite treatment will be completed before crawl space upgrade and inspected in accordance with the 2012 IRC	Prepare site for upgrade
2.0111.2f	Structural repairs, modifications	Structural repairs and modifications will be inspected and completed before crawl space upgrade in accordance with the 2012 IRC	Prepare site for upgrade
2.0111.2g	Appliance and heating, ventilation, and air conditioning (HVAC) system repairs and change outs	Crawl space upgrades (e.g., sealing and insulation) are to be undertaken after appliance and HVAC system work has been completed and inspected in accordance with the 2012 IRC and/or the authority having jurisdiction	Prepare site for upgrade
2.0111.2h	Correctable standing water	Passive drains or sump pumps will be used to remove standing water	Prepare site for upgrade
2.0111.2i	Non-correctable standing water	Spaces with non-correctable standing water will not be considered for a closed crawl space	Prevent possible damage to house

2.0111.3 Crawl Spaces—Debris Removal

Topic: Safe Work Practices
Subtopic: Basements and Crawl Spaces
2.0111.3 Detail Name: Crawl Spaces—Debris Removal
Desired Outcome: Clean, safe, and easily accessible crawl space created

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
2.0111.3a	Debris removal	Under-floor grade will be removed of all vegetation and organic material, unnecessary material, and debris greater than 1" will be removed from the crawl space (e.g., rake the crawl space)	Minimize punctures in ground liner Minimize habitat for pests (Integrated Pest Management—IPM) and contaminant sources
2.0111.3b	Debris disposal	Debris will be properly disposed of according to type and jurisdiction	Protect environment from damage

2.0111.4 Negative Pressure Contamination Control

Topic: Safe Work Practices
Subtopic: Basements and Crawl Spaces
2.0111.4 Detail Name: Negative Pressure Contamination Control
Desired Outcome: Contaminants prevented from entering house during work process

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
2.0111.4a	Exterior sealing	Openings in the crawl space exterior foundation wall will be closed to maximize negative pressure (close the vents)	Minimize leakage area between crawl space and exterior
2.0111.4b	Interior sealing	Penetrations between the crawl space and living space will be sealed	Minimize air leakage from crawl space to living space
2.0111.4c	Pressure	A device will be installed (e.g., fan) to exhaust air out of the crawl space until the ground moisture barrier is installed in the crawl space A negative pressure will be maintained in the crawl space with reference to the house	Prevent contaminants from entering house

2.0201.1 Combustion Appliance Zone (CAZ) Testing

Topic: Combustion Safety
Subtopic: Combustion Safety Testing—General
2.0201.1 Detail Name: Combustion Appliance Zone (CAZ) Testing
Desired Outcome: Accurate information about appliance safe operation is gathered

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
2.0201.1a	Assessment	Emergency problems (e.g., gas leak, ambient CO levels that exceed 35 ppm) will be communicated clearly and immediately to the customer and appropriate solutions will be suggested Determine if combustion and dilution air is adequate for proper combustion and venting of all equipment within the CAZ Examine appliance for signs of damage, misuse, improper repairs, and lack of maintenance	Ensure system does not have fatal problems Ensure combustion appliance has adequate combustion and dilation air
2.0201.1b	Fuel leak detection	Inspect and test for gas or oil leakage at connections of natural gas, propane piping, or oil systems If leaks are found, immediate action will be taken to notify occupant to help ensure leaks are repaired The report will specify repair for leaks and replacement for hazardous or damaged gas or oil connectors and pipes	Detect fuel gas leaks Determine and report need for repair
2.0201.1c	Venting	Combustion venting systems will be inspected for damage, leaks, disconnections, inadequate slope, and other safety hazards	Determine if a regulator is present and working and if vent system is in good condition and installed properly
2.0201.1d	Base pressure test	Baseline pressure will be measured in Combustion Appliance Zone with reference to outdoors	Measure pressure difference between combustion zone and the outside under natural conditions
2.0201.1e	Depressurization test	Depressurization test will include exhaust fans, interior door closure, or duct leakage, or a combination thereof, and will not be more negative than -3 pascals accounting for base pressure	Measure combined effect of mechanical system fans on combustion zone
2.0201.1f	Spillage test	If a combustion appliance spillage exceeds two minutes during pressure testing, specify measures to mitigate	Detect excessive spillage of combustion gasses
2.0201.1g	Carbon monoxide (CO) test in appliance vent	CO will be tested for in undiluted flue gases of combustion appliances If CO levels exceed 200 ppm as measured, or 400 ppm air-free measurement, service will be provided to reduce CO to below these levels (unless CO measurement is within manufacturer specifications) If the outlet of the exhaust is accessible, include a CO test on all sealed-combustion, direct vent, and power-vented appliances (without atmospheric chimneys)	Measure CO and report excessive levels
2.0201.1i	Combustion safety testing at completion of retrofitting home	Upon completion of work, all homes receiving retrofits will receive combustion safety testing	Ensure work completed in home has not adversely affected the operation of combustion appliances

2.0201.2 Combustion Safety

Topic: Combustion Safety
Subtopic: Combustion Safety Testing—General
2.0201.2 Detail Name: Combustion Safety
Desired Outcome: Buildup of dangerous combustion byproducts in the living space prevented

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

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
2.0201.2a	Outside combustion make-up air	Combustion air will be provided from the outside and, where applicable, in accordance with the 2012 IRC for the type of appliance installed	Prevent combustion byproducts from entering the house
2.0201.2b	New appliances	If replacing appliances, a sealed-combustion, direct-vent appliance will be installed in accordance with manufacturer specifications, 2012 IRC G2427.8, and additional applicable codes Replacement equipment venting will be assessed to ensure other existing equipment is not adversely affected	Prevent combustion byproducts from entering the house
2.0201.2c	CO detection and warning equipment	CO detection or warning equipment will be installed outside of each separate sleeping area in the immediate vicinity of the bedrooms in accordance with ASHRAE 62.2 and authority having local jurisdiction	Alert occupant to CO exposure
2.0201.2d	Gas ovens	Gas ovens will be tested for CO A clean and tune will be conducted if CO in the flue gas in the oven vent exceeds 200 ppm as measured, or 800 ppm air-free measurement, at steady state	Ensure clean burn of gas ovens
2.0201.2e	Gas range burners	Specify clean and tune if the flame has any discoloration, flame impingement, or an irregular pattern or if burners are visibly dirty, corroded, or bent	Ensure clean burn and operation of gas range burners
2.0201.2f	Solid fuel burning appliances	Replacement of solid fuel burning appliance with UL-listed and EPA-certified appliances if the existing appliance is not UL-listed or has signs of structural failure	Ensure safe operations of solid fuel burning appliances

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

Topic: Combustion Safety
Subtopic: Unvented Space Heaters
2.0202.1 Detail Name: Unvented Space Heaters: Propane, Natural Gas, and Kerosene Heaters
Desired Outcome: Elimination of combustion byproducts

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
2.0202.1a	Removal	With the occupant's permission, unvented heaters will be removed except when used as a secondary heat source and when it can be confirmed that the unit is listed to ANSI Z21.11.2 Units that are not being operated in compliance with ANSI Z21.11.2 should be removed before the retrofit but may remain until a replacement heating system is in place Failure to remove unvented space heaters serving as primary heat sources has the potential to create hazardous conditions and thus any further weatherization services will be re-evaluated in the context of potential indoor air quality risks	Eliminate sources of combustion byproduct within a living space
2.0202.1b	Occupant education	Occupant will be educated on potential hazards of unvented combustion appliances (primary or secondary) within a living space	Inform occupant about possible hazards associated with combustion byproducts and moisture

2.0203.1 Combustion Air for Natural Draft Appliances

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

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
2.0203.1a	Required combustion air	The required volume of indoor air will be determined in accordance with Section G2407.5.1 or G2407.5.2 and authority having jurisdiction, except that where the air infiltration rate is known to be less than 0.40 air changes per hour (ACH), Section G2407.5.2 will be used	Determine if existing conditions meet the combustion air calculation
2.0203.1b	Additional combustion air (if action is required)	Additional combustion air will be provided in accordance with 2012 IRC G2407 and authority having jurisdiction	Ensure adequate combustion air for operation of the appliance

2.0203.2 Combustion Flue Gas—Orphaned Water Heaters

Topic: Combustion Safety
Subtopic: Vented Gas Appliances
2.0203.2 Detail Name: Combustion Flue Gas—Orphaned Water Heaters
Desired Outcome: Flue gasses successfully removed from the house

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
2.0203.2a	Spillage testing	If a combustion appliance spillage exceeds two minutes during pressure testing, specify measures to mitigate	Ensure appliance is not spilling longer than two minutes
2.0203.2b	Flue gas removal (chimney liner or approved methods)	A chimney liner will be installed in accordance with the 2012 IRC or applicable NFPA standard	Allow water heater to vent properly Prevent damage to the chimney
2.0203.2c	Retesting spillage	If a combustion appliance spillage exceeds two minutes during pressure testing, specify measures to mitigate	Ensure appliance is not spilling longer than two minutes
2.0203.2d	Required combustion air	The minimum required volume will be 50 cubic feet per 1,000 Btu/h in accordance with 2012 IRC G2407.5.1 and authority having jurisdiction	Determine if existing conditions meet the combustion air calculation
2.0203.2e	Additional combustion air (if action is required)	Additional combustion air will be provided in accordance with 2012 IRC G2407 or other authority having jurisdiction	Ensure adequate combustion air for operation of the appliance
2.0203.2f	Occupant health and safety	All homes will have a functioning CO alarm If CO levels in interior living spaces exceed outdoor levels, investigate potential sources and take appropriate action to reduce them (e.g., have a qualified professional tune, repair or replace improperly operating combustion appliances; apply weather stripping or conduct air sealing between the garage or crawl space and the home)	Ensure occupant health and safety Ensure indoor CO levels do not exceed outdoor CO levels
2.0203.2g	Occupant education	Occupants will be educated on the operation and maintenance of the CO alarm Completed work on combustion appliances and recommended maintenance will be reviewed with occupant Occupant will be provided information regarding the health effects and risk of high CO concentrations; EPA describes possible expanded actions, and offers client education information in an appendix to the protocols	Ensure occupant can operate and maintain installations Inform occupant regarding possible CO hazards

2.0203.3 Draft Regulation—Category I Appliance

Topic: Combustion Safety
Subtopic: Vented Gas Appliances
2.0203.3 Detail Name: Draft Regulation—Category I Appliance
Desired Outcome: Build-up of flue gasses prevented with proper drafting

For supporting reference material, see Appendix C.

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

2.0299.1 Combustion Appliance Depressurization Limits Table

Topic: Combustion Safety
Subtopic: Additional Resources
2.0299.1 Combustion Appliance Depressurization Limits Table
Desired Outcome: Ensure appliances meet manufacturer's certified negative pressure tolerance rating

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
2.0299.1a	Atmospheric water heater only (Category I, natural draft), open-combustion appliances	Manufacturer's certified negative pressure tolerance rating: • Limit -2 pascals	Ensure appliances meet manufacturer's certified negative pressure tolerance rating
2.0299.1b	Atmospheric water heater (Category I, natural draft) and atmospheric furnace (Category I, natural draft), common-vented, open-combustion appliances	Manufacturer's certified negative pressure tolerance rating: • Limit -3 pascals	Ensure appliances meet manufacturer's certified negative pressure tolerance rating
2.0299.1c	Gas furnace or boiler, Category I or Category I fan-assisted, open-combustion appliances	Manufacturer's certified negative pressure tolerance rating: • Limit -5 pascals	Ensure appliances meet manufacturer's certified negative pressure tolerance rating
2.0299.1d	Oil or gas unit with power burner, low- or high-static pressure burner, open combustion appliances	Manufacturer's certified negative pressure tolerance rating: • Limit -5 pascals	Ensure appliances meet manufacturer's certified negative pressure tolerance rating

2.0299.1e	Closed, controlled wood-burning appliances	Manufacturer's certified negative pressure tolerance rating: • Limit -7 pascals	Ensure appliances meet manufacturer's certified negative pressure tolerance rating
2.0299.1f	Induced-draft appliances (fan at point of exit at wall), Category I with induced draft, open-combustion appliances	Manufacturer's certified negative pressure tolerance rating: • Limit -15 pascals	Ensure appliances meet manufacturer's certified negative pressure tolerance rating
2.0299.1g	Pellet stoves with exhaust fan and sealed vent	Manufacturer's certified negative pressure tolerance rating: • Limit -15 pascals	Ensure appliances meet manufacturer's certified negative pressure tolerance rating
2.0299.1h	Gas appliances, Category III vented through the wall, forced draft, open-combustion appliances	Manufacturer's certified negative pressure tolerance rating: • Limit -15 pascals	Ensure appliances meet manufacturer's certified negative pressure tolerance rating
2.0299.1i	Direct-vent, sealed combustion appliances with forced draft	Manufacturer's certified negative pressure tolerance rating: • Limit -25 pascals	Ensure appliances meet manufacturer's certified negative pressure tolerance rating

2.0301.1 Smoke Alarm

Topic: Safety Devices
Subtopic: Combustion Safety Devices
2.0301.1 Detail Name: Smoke Alarm
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 reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
2.0301.1a	Smoke alarm (hardwired)	Smoke alarms will be listed and labeled in accordance with UL 217 and installed (hardwired) in accordance with the 2012 IRC or as required by the authority having jurisdiction	Ensure proper installation
2.0301.1b	Smoke alarm (battery operated)	Battery operated alarms will be installed in accordance with the 2012 IRC and manufacturer specifications	Ensure proper installation

2.0301.2 Carbon Monoxide Alarm or Monitor

Topic: Safety Devices
Subtopic: Combustion Safety Devices
2.0301.2 Detail Name: Carbon Monoxide Alarm or Monitor
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 reference material, see Appendix C.

ROW	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 ASHRAE 62.2 or as required by the authority having jurisdiction	Ensure proper installation
2.0301.2b	CO detection and warning equipment (battery operated)	Battery operated CO detection or warning equipment will be installed in accordance with ASHRAE 62.2 and manufacturer specifications as required by the authority having jurisdiction	Ensure proper installation

2.0401.1 Air Sealing Moisture Precautions

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

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
2.0401.1a	Moisture precautions for attics	Roof leaks will be repaired before performing attic air sealing or insulation Moisture sources in the house that can generate moisture into the attic will be identified and removed or reduced	Ensure durability of repairs Reduce potential for occupant exposure to mold and other moisture-related hazards Prevent moisture from communicating from within the conditioned space into unconditioned attic space when economically feasible
2.0401.1b	Moisture precautions for crawl spaces	Exposed earth will be covered with a continuous, durable, sealed Class 1 vapor retarder a minimum of 6 millimeters in thickness Plastic, foil or any other Class 1 vapor barrier/retarder will not be used in hot-humid climates All accessible penetrations between the crawl space or basement and outside will be sealed Holes between the crawl space or basement and the living space will be sealed	Ensure durability of repairs Reduce potential for occupant exposure to mold and other moisture-related hazards
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 62.2-2010 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
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 Environmental Protection Agency (EPA) Indoor airPLUS Construction Specifications Section 1.1 • Possible mitigation by waterproofing or installing draining plane with construction adhesive	Reduce potential for occupant exposure to mold and other moisture-related hazards

2.0401.2 Vented Crawl Space—Venting

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

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
2.0401.2a	Venting	Venting will be performed in accordance with the 2012 IRC and local codes	Provide ventilation for pollutant sources (e.g., moisture, radon, soil gases)

2.0402.1 Crawl Spaces—Drainage

Topic: Moisture
Subtopic: Drainage
2.0402.1 Detail Name: Crawl Space—Drainage
Desired Outcome: Water and conditions conducive to mold growth, wood rot, and pests eliminated

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
2.0402.1a	Exterior grading	Ground will be sloped away from the house at a rate of 6" of fall within 10'	Drain water away from the foundation wall
2.0402.1b	Roof drainage	If downspouts are present (e.g., gutters, overhangs, French drain), they will be drained a minimum of 6' away from the house	Prevent roof water from leaking into the crawl space or basement
2.0402.1c	Exterior waterproofing	Foundation walls will be waterproof Exterior foundation drains will be installed	Prevent water from leaking into the crawl space or basement
2.0402.1d	Interior grading	Interior grading will be sloped to one or more collection points, if possible	Collect interior water for removal
2.0402.1e	Interior drainage	One or more drains or sump pumps will be installed	Remove interior water from the crawl space or basement

2.0403.1 Vented Crawl Spaces—Ground Moisture Barrier

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

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
2.0403.1a	Scheduling	The ground moisture barrier will be installed last	Protect ground moisture barrier from damage during other crawl space work
2.0403.1b	Coverage	A ground moisture barrier that covers 100% of the exposed crawl space floor will be installed	Reduce ground moisture entering the crawl space
2.0403.1c	Material specification	A ground moisture barrier with a rating of no more than 0.1 perm will be used A minimum expected service life of 10 years will be ensured A ground moisture barrier will be used that meets tear and puncture resistance standard ASTM D703	Ensure crawl space is accessible for service and maintenance without damaging the integrity of the ground moisture barrier
2.0403.1d	Overlap seams	When seams exist, they will be overlapped a minimum of 12" using "reverse" or "upslope lapping" technique	Keep water under the liner Reduce the likelihood of damage at seams
2.0403.1e	Fastening	Ground moisture barrier will be fastened to ground with durable fasteners or ballast(s) and extend a minimum of 6" up the foundation wall A minimum expected service life of 10 years will be ensured	Prevent movement of the ground moisture barrier

2.0403.2 Closed Crawl Spaces—Ground Moisture Barriers

Topic: Moisture
Subtopic: Vapor Barriers
2.0403.2 Detail Name: Closed Crawl Spaces—Ground Moisture Barriers
Desired Outcome: Durable, effective air barrier and ground moisture barrier provide ongoing access and minimize ground vapor

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
2.0403.2a	Scheduling	Air barrier and ground moisture barrier will be installed last	Protect air barrier and ground moisture barrier from damage during other work in the crawl space
2.0403.2b	Coverage	An air barrier and ground moisture barrier, covering 100% of the exposed crawl space floor, will be installed and sealed to the wall's air and moisture barrier Ground moisture barrier will be fastened to ground with durable fasteners or ballast(s) and extend a minimum of 6" up the foundation wall	Reduce ground vapor entering the crawl space Create a continuous and durable connection between the wall and ground air and moisture barriers
2.0403.2c	Material specification	A ground moisture barrier with a rating of no more than 0.1 perm will be used A minimum expected service life of 10 years will be ensured A ground moisture barrier will be used that meets tear and puncture resistance standard ASTM D703	Reduce ground vapor entering the crawl space Ensure crawl space is accessible for service and maintenance without destroying the integrity of the moisture barrier
2.0403.2d	Overlap seams	When seams exist, they will be overlapped a minimum of 12" with "reverse" or "upslope lapping" technique For wall to floor connection, the wall moisture barrier will be installed under the ground moisture barrier	Keep water under the liner
2.0403.2e	Fastening	The air barrier and ground moisture barrier will be fastened to the ground to prevent movement A minimum expected service life of 10 years will be ensured	Prevent movement and uplift of the air barrier and ground moisture barrier
2.0403.2f	Sealing seams	A durable sealant compatible with the air barrier and ground moisture barrier will be used A minimum expected service life of 10 years will be ensured	Maintain continuous air barrier and ground moisture barrier
2.0403.2g	Air barrier, ground moisture barrier penetrations, including fastener penetrations	A durable sealant, compatible with the air barrier and ground moisture barrier, will be used Physical attachments will be provided where practical (e.g., masonry columns, footings) A minimum expected service life of 10 years will be ensured	Maintain continuous air barrier and ground moisture barrier
2.0403.2h	Drainage	The air barrier and ground moisture barrier will not interfere with the established drainage pattern	Ensure proper drainage
2.0403.2i	Drainage points	Interior drainage collection points will be accessible from above and below the air barrier and ground moisture barrier	Remove water above and below the air barrier and ground moisture barrier

2.0403.3 Closed Crawl Spaces—Vapor Retarders on Walls

Topic: Moisture
Subtopic: Vapor Barriers
2.0403.3 Detail Name: Closed Crawl Spaces—Vapor Retarders on Walls
Desired Outcome: Durable, effective vapor retarder minimizes leakage from ground and air

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
2.0403.3a	Air barrier and vapor retarder	An air barrier and vapor retarder will be installed on the interior side of the exterior wall in accordance with 2012 IRC R408. 3	Prevent air and moisture penetration
2.0403.3b	Coverage	An air barrier and vapor retarder will be installed a minimum of 1′ or as high as possible above outside grade	Prevent air and moisture penetration
2.0403.3c	Termite inspection gap	Where termite pressure exists, a 3″ inspection gap will be maintained from the top of the insulation to the bottom of any wood	Allow for termite detection
2.0403.3d	Attachment	Vapor retarder will be attached with a durable connection Vapor retarder will be sealed at punctures and all 12″ overlapped seams to prevent air entry A minimum expected service life of 10 years will be ensured	Ensure vapor retarder maintains a fixed position on the exterior wall Ensure vapor retarder is air tight
2.0403.3e	Piers and interior walls	Vapor retarder will be installed a minimum of 6″ above interior grade Vapor retarder will be attached with a durable connection Vapor retarder will be sealed at punctures and all 12″ overlapped seams to prevent air entry A minimum expected service life of 10 years will be ensured	Prevent ground moisture penetration

2.0404.1 Stand-Alone Dehumidifiers

Topic: Moisture
Subtopic: Space Conditioning
2.0404.1 Detail Name: Stand-Alone Dehumidifiers
Desired Outcome: Energy used to control humidity in conditioned spaces reduced

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
2.0404.1a	Selection	Equipment will have a minimum efficiency level of ENERGY STAR® or better Equipment will have a fan-off option Equipment will retain settings after power-off Equipment will have features that reduce both peak electric use (e.g., internal and external timers) and absolute energy use Equipment will have standby losses of 1 watt or less Controls will be labeled so they are understandable, readable, and accurate for occupant needs Systems located in a basement or crawl space will be rated for cold temperature operation Operating environment will be determined and appropriate equipment will be selected for that environment (e.g., low temperature and high relative humidity)	Reduce energy use Provide durable equipment Control moisture Provide equipment appropriate for occupant use
2.0404.1b	Installation	Installation will proceed only when the following applicable steps have been taken to control moisture: • Downspouts are re-directed away from foundation • Moisture from drying clothes is vented to the outside • Sump pit is covered and sealed • Dirt in crawl space is covered with a vapor barrier • Plumbing leaks are eliminated Equipment will be installed according to manufacturer specifications and meet all applicable codes Equipment will be installed to permit adequate air flow Equipment will have a timer for off-peak operation if time-of-use program is available and if the equipment can handle power interruptions Any penetrations to the exterior of the home created by the installation of the appliance will be sealed Initial relative humidity and temperature settings will be set by the installer to ensure the space does not reach dew point Operation of controls and needed maintenance will be reviewed with occupant A user guide for dehumidifier settings in different climate conditions will be created by the installer and provided to the occupant Installer will commission the equipment to ensure it is functioning properly An independent measurement will be made to verify relative humidity System will be connected directly to condensate line that drains to a plumbing drain or the exterior, away from the home's foundation and in compliance with the plumbing code or the authority having jurisdiction Specific information on the proper maintenance of the equipment will be provided to the occupant Warranty information, operation manuals, and installer contact information will be provided to the occupant	Reduce or retire dehumidifiers Reduce allergens and asthma triggers Improve health and reduce irritants Improve building durability Improve comfort Reduce pest populations Reduce risk of mold issues Educate occupant on how to operate and maintain equipment
2.0404.1c	Decommissioning	Removed equipment will be recycled or disposed of properly in accordance with local regulations	Prevent the reuse of inefficient equipment and its components Reduce waste Protect the environment

2.0404.2 Crawl Spaces—Preliminary Dehumidification

Topic: Moisture
Subtopic: Space Conditioning
2.0404.2 Detail Name: Crawl Spaces—Preliminary Dehumidification
Desired Outcome: A dry and moisture controlled space ensured

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
2.0404.2a	Close vents	Vents and other openings will be closed after ensuring sufficient combustion air for fuel-burning appliances in accordance with 2012 IRC G2407.5.1	Reduce moisture load coming from outside of the crawl space
2.0404.2b	Drying	If liquid moisture is present, the area will be dried until any liquid moisture is eliminated	Improve work environment Reduce moisture in the crawl space
2.0404.2c	Drying time	Space will be dehumidified until wood moisture content in solid, untreated lumber is less than 20%	Reduce moisture content of wood

2.0404.3 Closed Crawl Spaces—Crawl Space Conditioning

Topic: Moisture
Subtopic: Space Conditioning
2.0404.3 Detail Name: Closed Crawl Spaces—Crawl Space Conditioning
Desired Outcome: Humidity in closed crawl space is controlled to reduce moisture damage, energy consumption, and pests

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
2.0404.3a	No return pathway to living space	A return pathway from the crawl space to the living space will not be allowed	Improve IAQ in the living space
2.0404.3b	Option 1: dehumidifier	Option 1 may be used in combination with any other specified options A permanent, low-temperature, auto-restart, minimum ENERGY STAR® rated dehumidifier will be installed with a minimum rated capacity of 15 pints per day Condensate will be drained to daylight or a condensation pump	Maintain low relative humidity Reduce conditions conducive to pest activity Reduce conditions conducive to mold growth and wood rot Improve IAQ in the conditioned space Improve equipment service life Save energy in cooling-dominated climates
2.0404.3c	Option 2: supply air	Option 2 may be used in combination with any other specified options Air from a central forced-air conditioning system will be supplied at a rate of 1 cubic foot per minute (CFM) per 30 square feet of closed crawl space area The supply air duct will be fitted with a backflow damper	Maintain low relative humidity Reduce conditions conducive to pest activity Reduce conditions conducive to mold growth and wood rot Improve IAQ in the conditioned space Improve equipment service life Save energy in cooling-dominated climates Prevent crawl space air from entering the living space when forced air system is off

2.0404.3d	Option 3: conditioned house air	Option 3 may be used in combination with any other specified options A continuous-duty, Home Ventilation Institute (HVI)-rated, 1-sone or less fan will be installed that supplies 1 CFM of conditioned house air per 50 square feet of closed crawl space area Optional: An air relief vent to the outside having backdraft protection may be installed	Maintain low relative humidity Reduce conditions conducive to pest activity Reduce conditions conducive to mold growth and wood rot Improve IAQ in the conditioned space Improve equipment service life Save energy in cooling-dominated climates
2.0404.3e	Option 4: exhaust	A continuous-duty, HVI-rated, 1 sone or less fan will be installed that exhausts 1 CFM of closed crawl space air per 50 square feet of closed crawl space area This option will not be installed for exhaust crawl space ventilation if a radon mitigation system is installed or anticipated in the crawl space	Maintain low relative humidity Reduce conditions conducive to pest activity Reduce conditions conducive to mold growth and wood rot Improve IAQ in the conditioned space Improve equipment service life Save energy in cooling-dominated climates
2.0404.3f	Monitoring alarm system	A durable humidity monitoring system with alarm capability will be installed A minimum expected service life of 10 years will be ensured	Alert occupant to system failure

2.0404.4 Basements—Dehumidification

Topic: Moisture
Subtopic: Space Conditioning
2.0404.4 Detail Name: Basement—Dehumidification
Desired Outcome: Basement humidity controlled with supplemental dehumidification

For supporting reference material, see Appendix C.

ROW	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
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
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
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
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
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

2.0501.1 Radon—Air Sealing Considerations

Topic: Radon
Subtopic: Air Sealing
2.0501.1 Detail Name: Radon—Air Sealing Considerations
Desired Outcome: Work completed without increasing occupant exposure to radon

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
2.0501.1a	Radon testing and mitigation	Radon testing and mitigation will be done in accordance with the Environmental Protection Agency (EPA) Healthy Indoor Environment Protocols for Home Energy Upgrades	Reduce potential for occupant exposure to radon

2.0501.2 Radon—Basements and Crawl spaces

Topic: Radon
Subtopic: Air Sealing
2.0501.2 Detail Name: Radon—Basements and Crawl spaces
Desired Outcome: Work completed without increasing occupant exposure to radon

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
2.0501.2a	Radon testing and mitigation	Radon testing and mitigation will be done in accordance with the Environmental Protection Agency (EPA) Healthy Indoor Environment Protocols for Home Energy Upgrades	Reduce potential for occupant exposure to radon

2.0601.1 Knob and Tube Wiring

Topic: Electrical
Subtopic: Knob and Tube Wiring
2.0601.1 Detail Name: Knob and Tube Wiring
Desired Outcome: Live unsafe wiring identified and brought to local codes

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

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
2.0601.1a	Knob and tube identification	Contractor, assessor, auditor, or similar will inspect and assess the house to identify knob and tube wiring	Ensure occupant safety Preserve the integrity and safety of the house
2.0601.1b	Live wire testing	Non-contact testing method will be used to determine if wiring is live	Protect occupant safety Preserve the integrity and safety of the house

2.0601.1c	Isolation and protection	Live knob and tube will not be covered or surrounded; required by the National Electrical Code (NEC) or authority having jurisdiction A licensed electrical contractor will inspect and certify wiring to be safe and place a warning at all entries to the attic about the presence of knob and tube wiring A dam that does not cover the top will be created to separate insulation from the wire path	Ensure occupant safety Preserve the integrity and safety of the house
2.0601.1d	Replacement	Exposed wiring will be replaced with new appropriate wiring in accordance with the NEC and local codes Old wiring will be rendered inoperable by licensed electrician in accordance with the NEC and local codes	Ensure occupant safety Preserve the integrity and safety of the house

2.0701.1 Crawl Spaces—Providing Access

Topic: Occupant Education and Access
Subtopic: Basements and Crawl Spaces
2.0701.1 Detail Name: Crawl Spaces—Providing Access
Desired Outcome: Access to the closed crawl space is controlled and the ground moisture barrier is protected to maintain the integrity of the system

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
2.0701.1a	Access	Crawl space will be accessible in accordance with 2012 IRC R408.4 Access to mechanical equipment located in the crawl space will be in accordance with 2012 IRC M1305.1.4 Service and maintenance of the crawl space and equipment will be performed without risk of damage to the thermal barrier, air barrier, and ground moisture barrier in accordance with 2012 IRC N1102.2.4 and 2012 IRC AF103.4.10	Provide crawl space access Maintain integrity of the crawl space system
2.0701.1b	Lock	A lockable access will be provided if access is from the exterior	Control access and prevent intruders

2.0701.2 Crawl Space Information Sign

Topic: Occupant Education and Access
Subtopic: Basements and Crawl Spaces
2.0701.2 Detail Name: Crawl Space Information Sign
Desired Outcome: Posted signs inside of the crawl space provide essential safety and maintenance information to occupant and users of the crawl space

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
2.0701.2a	Sign specifications	A durable, easily seen sign will be installed at all accesses inside of the crawl space (minimum 8 ½″ x 11″) A minimum expected service life of 10 years will be ensured	Prevent damage to the crawl space after upgrade
2.0701.2b	Sign content	Those entering the crawl space will be cautioned not to damage the air barrier, ground moisture barrier, insulation, and mechanical components specific to the crawl space type Anyone entering the crawl space will be alerted that immediate repairs are needed in case of damage Installer contact information will be included on the sign in case there are questions or needs for repairs	Prevent damage to the crawl space after upgrade Educate anyone entering the crawl space Provide occupants with a way to contact the installer
2.0701.2c	Hazard warning	Language prohibiting storage of hazardous and flammable materials will be provided on site	Prevent storage of hazardous or flammable materials in the crawl space Maintain indoor air quality Prevent a fire hazard

2.0701.3 Crawl Space—Occupant Education

Topic: Occupant Education and Access
Subtopic: Basements and Crawl Spaces
2.0701.3 Detail Name: Crawl Space—Occupant Education
Desired Outcome: Occupants educated on the crawl space system and how to maintain it

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
2.0701.3a	Written communication	Occupants will be given written documentation that describes components of the system, maintenance requirements, and health and safety considerations at a minimum Information will be provided in simple terms Text and pictures will be used Documentation may be provided electronically Literacy levels and language of occupants will be considered in selecting appropriate materials	Provide occupant with a basic understanding and documentation of the system, its maintenance, and related health and safety issues
2.0701.3b	Oral communication	When possible, the written documents will be reviewed with the occupants	Confirm that occupants have received the information Provide an opportunity for questions and answers
2.0701.3c	Contact information	Information about the installation company and warranty will be provided	Provide occupants with a way to contact the installer

2.0702.1 Warranty and Service Agreement

Topic: Occupant Education and Access
Subtopic: Installed Equipment
2.0702.1 Detail Name: Warranty and Service Agreement
Desired Outcome: Occupants provided recourse for failures in materials, workmanship, and serviceability and informed of potential hazards

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
2.0702.1a	Warranty	A minimum 1-year warranty for materials, workmanship, and serviceability will be provided to occupants upon completion of work	Provide recourse to occupants for failures in materials, workmanship, and serviceability
2.0702.1b	Warranty renewal and service agreement	An option for annual inspection and renewal of warranty and service agreement for up to 10 years will be offered at a cost (requirement for installers)	Provide occupants with an option for extending the warranty and service agreement
2.0702.1c	General conditions	At a minimum, the following concerns and warnings will be addressed within the warranty: • Possible drying and shrinking effects • Storage of hazardous and flammable materials • Mold	Educate occupants on potential hazards

Section 3: Air Sealing

3.1001.1 Penetrations and Chases

Topic: Attics
Subtopic: Penetrations and Chases
3.1001.1 Detail Name: Penetrations and Chases
Desired Outcome: Penetrations and chases sealed to prevent air leakage and moisture movement between the attic and conditioned space

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
3.1001.1a	Pre-inspection	An inspection will be conducted for mold, water leaks, and water damage before sealing a chase Repairs will be completed before work	Repair moisture-related issues
3.1001.1b	Backing and infill	Backing or infill will be provided as needed to meet the specific characteristics of the selected material and the characteristics of the hole The infill or backing will not bend, sag, or move once installed	Minimize hole size to ensure successful use of sealant Ensure closure is permanent and supports any load (e.g., wind, insulation) Ensure sealant does not fall out
3.1001.1c	Sealant selection	Sealants will be compatible with their intended surfaces Sealants will allow for differential expansion and contraction between dissimilar materials Sealants will be continuous and meet fire barrier specifications, according to authority having jurisdiction	Select permanent sealant Ensure sealant meets or exceeds the performance characteristics of the surrounding materials
3.1001.1d	High temperature application	Only non-combustible sealant will be used in contact with chimneys, vents, and flues Local codes will be referenced	Prevent a fire hazard

3.1001.2 Chase Capping

Topic: Attics
Subtopic: Penetrations and Chases
3.1001.2 Detail Name: Chase Capping
Desired Outcome: Chase capped to prevent air leakage and moisture movement between the attic and conditioned space

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
3.1001.2a	Pre-inspection	An inspection will be conducted for mold, water leaks, and water damage before sealing a chase Repairs will be completed before work begins	Repair moisture-related issues
3.1001.2b	Standard chase (interior walls covered with drywall or plaster)	Entire opening will be spanned with rigid material Material will be cut to fit and fastened as required	Reduce opening to what can be sealed with sealant
3.1001.2c	Non-standard chase (interior walls covered with wood or paneling)	Material will be used that can be exposed to the interior of the house and meet the flame and smoke spread indexes as required in 2012 IRC R302.9	Prevent a fire hazard
3.1001.2d	Support	Support material will be installed for spans wider than 24", except when air barrier material is rated to span greater distance under load (e.g., wind, insulation)	Ensure seal stays in place and does not sag
3.1001.2e	Joint seal	Continuous seal will be installed around seams, cracks, joints, edges, penetrations, and connections	Provide airtight, durable seal that does not move, bend, or sag
3.1001.2f	Adjacent framing	All remaining gaps at the top of the chase will be sealed	Ensure airtight seal from one finished side of the chase to the other

3.1001.3 Walls Open to Attic—Balloon Framing and Double Walls

Topic: Attics
Subtopic: Penetrations and Chases
3.1001.3 Detail Name: Walls Open to Attic—Balloon Framing and Double Walls
Desired Outcome: Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
3.1001.3a	Pre-inspection	An inspection will be conducted for mold, water leaks, and water damage before sealing a dropped ceiling or soffit Repairs will be completed before work begins	Repair moisture-related issues
3.1001.3b	Sealing methods	Entire opening will be spanned with rigid material in line with the ceiling level Material will be cut to fit and fastened as required OR Wall below openings will be dense packed OR Wall below openings will be bridged and sealed with spray polyurethane foam (SPF) Sealants will be used that prevent visible air movement using chemical smoke at 50 pascals of pressure difference	Prevent air leakage from wall cavity to attic
3.1001.3c	Support	Support material will be installed for spans wider than 24", except when air barrier material is rated to span greater distance under load (e.g., wind, insulation)	Ensure seal stays in place and does not sag
3.1001.3d	Joint seal	Continuous seal will be installed around seams, cracks, joints, edges, penetrations, and connections	Provide airtight, durable seal that does not move, bend, or sag
3.1001.3e	Adjacent framing	All remaining gaps at the top of the opening will be sealed OR All remaining gaps at the top of the chase will be sealed	Ensure airtight seal from one finished side of the wall assembly to the other

3.1002.1 Interior with Sloped Ceiling

Topic: Attics
Subtopic: Open Stairwells
3.1002.1 Detail Name: Interior with Sloped Ceiling
Desired Outcome: Stairwells sealed to prevent air leakage and moisture movement between the attic and conditioned space

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
3.1002.1a	Pre-inspection	An inspection will be conducted for mold, water leaks, and water damage before sealing an open stairwell Repairs will be completed before work begins	Repair moisture-related issues
3.1002.1b	Standard void over stairwell (15-minute fire-rated material; e.g., gypsum lined)	Entire opening will be spanned with rigid material Material will be cut to fit and fastened as required	Prevent air leakage from wall to attic Reduce opening to what can be sealed with sealant Support load as required (e.g., wind, insulation)

3.1002.1c	Non-standard void over stairwell (surfaces around void are not 15-minute fire-rated (e.g., bookcases, chest of drawers), or lined with paneling or other non-fire-rated material)	Material will be used that can be exposed to the interior of the house	Prevent a fire hazard
3.1002.1d	Support	Support material will be installed for spans wider than 24", except when air barrier material is rated to span greater distance under load (e.g., wind, insulation)	Ensure seal stays in place and does not sag
3.1002.1e	Joint seal	Continuous seal will be installed around seams, cracks, joints, edges, penetrations, and connections	Provide airtight, durable seal that does not move, bend, or sag
3.1002.1f	Perimeter sealing	Air barrier will be extended on all four sides from finished ceiling or existing framing to the new barrier Access will be gained as needed (e.g., pull flooring)	Create a continuous air barrier

3.1002.2 Stairwell to Attic—Door at Bottom with No Ceiling Above

Topic: Attics
Subtopic: Open Stairwells
3.1002.2 Detail Name: Stairwell to Attic—Door at Bottom with No Ceiling Above
Desired Outcome: Stairwell sealed to prevent air leakage and moisture movement between the attic and the conditioned space

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
3.1002.2a	Pre-inspection	An inspection will be conducted for mold, water leaks, and water damage before sealing an open stairwell Repairs will be completed before work begins	Repair moisture-related issues
3.1002.2b	Option 1: bring stairwell inside	Materials will be installed in line with the ceiling level with an airtight and operable insulated panel weighing no more than 15 pounds, or a pre-fabricated kit may be used for repeated access OR Airtight seal will be provided between level of new closure or cap and interior ceiling around perimeter Access will be gained as needed (e.g., pull flooring)	Prevent air leakage through stairwell between conditioned space and attic Ensure the insulated panel is lightweight and easy for the occupant to use on an ongoing basis Support insulation Bring the stairwell inside of the thermal boundary Ensure the new closure ties into the existing air barrier on all sides
3.1002.2c	Option 2: keep stairwell outside	An air barrier will be created and insulation material will be continuously installed across all surfaces of stairwell, including weather-stripped and insulated doors OR All cavities between stairs and conditioned space will be insulated and tested to resist air flow (e.g., walls, floors, landings, under stairs) Door will be weatherstripped and insulated OR A combination of the above methods can be used	Prevent air leakage Provide continuous thermal boundary Maximize thermal performance
3.1002.2d	Support	Support material will be installed for spans wider than 24", except when air barrier material is rated to span greater distance under load (e.g., wind, insulation)	Ensure seal stays in place and does not sag
3.1002.2e	Joint seal	Continuous, airtight seals will be provided around seams, cracks, joints, edges, penetrations, and connections	Provide airtight, durable seal that does not move, bend, or sag
3.1002.2f	Perimeter sealing	Air barrier will be extended on all four sides from finished ceiling or from existing framing to the new barrier Access will be gained as needed (e.g., pull flooring)	Create a continuous air barrier

3.1002.3 Stairwell to Attic—Door at Top with Finished Ceiling Above

Topic: Attics
Subtopic: Open Stairwells
3.1002.3 Detail Name: Stairwell to Attic—Door at Top with Finished Ceiling Above
Desired Outcome: Stairwell is sealed to prevent air leakage and moisture movement between the attic and conditioned space

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
3.1002.3a	Pre-inspection	An inspection will be conducted for mold, water leaks, and water damage before sealing an open stairwell Repairs will be completed before work begins	Repair moisture-related issues
3.1002.3b	Option 1: bring stairwell inside	An airtight seal will be provided between level of new closure or cap and interior ceiling around perimeter Access will be gained as needed (e.g., pull flooring) OR An air barrier will be created and insulation material will be continuously installed across all surfaces of stairwell, including weather-stripped and insulated doors OR All cavities between stairs and conditioned space will be insulated and tested to resist air flow (e.g., walls, floors, landings, under stairs) Door will be weatherstripped and insulated OR A combination of the above methods can be used	Reduce air leakage Provide continuous thermal boundary Maximize thermal performance
3.1002.3c	Support	Support material will be installed for spans wider than 24", except when air barrier material is rated to span greater distance under load (e.g., wind, insulation)	Ensure seal stays in place and does not sag
3.1002.3d	Joint seal	Continuous, airtight seals will be provided around seams, cracks, joints, edges, penetrations, and connections	Provide airtight, durable seal that does not move, bend, or sag
3.1002.3e	Perimeter sealing	Air barrier will be extended on all four sides from finished ceiling or existing framing to the new barrier Access will be gained as needed (e.g., pull flooring)	Create a continuous air barrier

3.1003.1 New Ceiling Below Original—Old Ceiling Intact or Repairable

Topic: Attics
Subtopic: Dropped Ceilings and Soffits
3.1003.1 Detail Name: New Ceiling Below Original—Old Ceiling Intact or Repairable
Desired Outcome: Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
3.1003.1a	Pre-inspection	An inspection will be conducted for mold, water leaks, and water damage before sealing a dropped ceiling or soffit Repairs will be completed before work begins	Repair moisture-related issues
3.1003.1b	Sealing methods	Entire opening will be spanned with rigid material in line with the ceiling level Material will be cut to fit and fastened as required OR Side of stud bays will be sealed with rigid material from bottom of dropped ceiling to top-plate OR Wall below openings will be dense packed OR Wall below openings will be bridged and sealed with SPF Seals will be used that prevent visible air movement using chemical smoke at 50 pascals of pressure difference	Prevent air leakage from dropped ceiling to attic
3.1003.1c	Support	Support material will be installed for spans wider than 24", except when air barrier material is rated to span greater distance under load (e.g., wind, insulation)	Ensure seal stays in place and does not sag
3.1003.1d	Joint seal	Continuous seal will be installed around seams, cracks, joints, edges, penetrations, and connections	Provide airtight, durable seal that does not move, bend, or sag
3.1003.1e	Adjacent framing	All remaining gaps will be sealed at the top of the dropped ceiling OR All remaining gaps at the top of the chase will be sealed	Provide airtight framing from one finished side of the dropped ceiling to the other

3.1003.2 Ceiling Leaks Not Repairable—No Air Barrier Above

Topic: Attics
Subtopic: Dropped Ceilings and Soffits
3.1003.2 Detail Name: Ceiling Leaks Not Repairable—No Air Barrier Above
Desired Outcome: Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
3.1003.2a	Pre-inspection	An inspection will be conducted for mold, water leaks, and water damage before sealing a dropped ceiling or soffit Repairs will be completed before work begins	Repair moisture-related issues
3.1003.2b	Sealing methods	Ceiling or roof and wall air and thermal barriers will be connected with a rigid airtight connection around the perimeter OR If ceiling will support an air barrier and insulation, a rigid airtight barrier (e.g., gypsum) will be attached to current ceiling either above or below OR Intermediate framing will be used to support air and thermal barrier OR Rigid airtight thermal barrier will be installed at the roof sheathing Seals will be used that prevent visible air movement using chemical smoke at 50 pascals of pressure difference	Prevent air leakage from dropped ceiling to attic
3.1003.2c	Support	Support material will be installed for spans wider than 24", except when air barrier material is rated to span greater distance under load (e.g., wind, insulation)	Ensure seal stays in place and does not sag
3.1003.2d	Joint seal	Continuous seal will be installed around seams, cracks, joints, edges, penetrations, and connections	Provide airtight, durable seal that does not move, bend, or sag
3.1003.2e	Adjacent framing	All remaining gaps will be sealed at the top of the dropped ceiling OR All remaining gaps at the top of the chase will be sealed	Provide airtight framing from one finished side of the dropped ceiling to the other

3.1003.3 Above Closets and Tubs

Topic: Attics
Subtopic: Dropped Ceilings and Soffits
3.1003.3 Detail Name: Above Closets and Tubs
Desired Outcome: Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
3.1003.3a	Pre-inspection	An inspection will be conducted for mold, water leaks, and water damage before sealing a dropped ceiling or soffit Repairs will be completed before work begins	Repair moisture-related issues
3.1003.3b	Above closets and tubs	Entire opening will be spanned with rigid material in line with the ceiling level Material will be cut to fit and fastened as required OR Side of stud bays will be sealed with rigid material from bottom of dropped ceiling to top-plate OR Wall below openings will be dense packed OR Wall below openings will be bridged and sealed with SPF Seals will be used that prevent visible air movement using chemical smoke at 50 pascals of pressure difference	Prevent air leakage from dropped ceiling to attic
3.1003.3c	Support	Support material will be installed for spans wider than 24", except when air barrier material is rated to span greater distance under load (e.g., wind, insulation)	Ensure seal stays in place and does not sag
3.1003.3d	Joint seal	Continuous seal will be installed around seams, cracks, joints, edges, penetrations, and connections	Provide airtight, durable seal that does not move, bend, or sag
3.1003.3e	Adjacent framing	All remaining gaps at the top of the dropped ceiling will be sealed	Provide airtight framing from one finished side of the dropped ceiling to the other

3.1003.4 3-D Walls

Topic: Attics
Subtopic: Dropped Ceilings and Soffits
3.1003.4 Detail Name: 3-D Walls
Desired Outcome: Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
3.1003.4a	Pre-inspection	An inspection will be conducted for mold, water leaks, and water damage before sealing a dropped ceiling or soffit Repairs will be completed before work begins	Repair moisture-related issues
3.1003.4b	Sealing methods	Entire opening will be spanned with rigid material installed in line with the ceiling level Material will be cut to fit and fastened as required OR Side of stud bays will be sealed with rigid material from bottom of dropped ceiling to top-plate OR Wall below openings will be dense packed OR Wall below openings will be bridged and sealed with SPF Seals will be used that prevent visible air movement using chemical smoke at 50 pascals of pressure difference	Prevent air leakage from dropped ceiling to attic

3.1003.4c	Support	Support material will be installed for spans wider than 24", except when air barrier material is rated to span greater distance under load (e.g., wind, insulation)	Ensure seal stays in place and does not sag
3.1003.4d	Joint seal	Continuous seal will be installed around seams, cracks, joints, edges, penetrations, and connections Pre-fabricated units may be used when meeting the desired outcome	Provide airtight, durable seal that does not move, bend or sag
3.1003.4e	Adjacent framing	All remaining gaps will be sealed at the top of the dropped ceiling OR All remaining gaps at the top of the chase will be sealed	Provide airtight framing from one finished side of the dropped ceiling to the other

3.1003.5 Dropped Ceiling with Light Boxes and Fixtures

Topic: Attics
Subtopic: Dropped Ceilings and Soffits
3.1003.5 Detail Name: Dropped Ceiling with Light Boxes and Fixtures
Desired Outcome: Sealed light boxes safely prevent air leakage and moisture movement between the attic and conditioned space

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
3.1003.5a	Pre-inspection	An inspection will be conducted for mold, water leaks, and water damage before sealing a dropped ceiling or soffit Repairs will be completed before work begins	Repair moisture-related issues
3.1003.5b	Light boxes (e.g., fluorescent lights)	An airtight seal will be provided around perimeter between light box enclosure and interior ceiling All seams and penetrations of the enclosure will be sealed Access will be gained as needed (e.g., pull flooring) Seals will be used that prevent visible air movement using chemical smoke at 50 pascals of pressure difference	Prevent air leakage
3.1003.5c	Non-insulation contact (IC) rated recessed lights	Insulation will be kept at least 3" away from the top and side of any fixtures If dropped ceiling is to be filled with insulation, then a sealed rigid barrier enclosure will be installed to maintain a 3" clearance on all sides and at least ½" from combustible materials Top of rigid barrier enclosure will be sealed with non-insulating rigid material (e.g., gypsum or equivalent perm rating and R-value)	Prevent light fixture from overheating Bring light fixture inside of the air barrier

3.1003.6 Dropped Soffits

Topic: Attics
Subtopic: Dropped Ceilings and Soffits
3.1003.6 Detail Name: Dropped Soffits
Desired Outcome: Dropped soffits sealed to prevent air leakage and moisture movement between the attic and conditioned space

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
3.1003.6a	Pre-inspection	An inspection will be conducted for mold, water leaks, and water damage before sealing a dropped ceiling or soffit Repairs will be completed before work begins	Repair moisture-related issues
3.1003.6b	Soffit general	Air flow will be blocked at soffit in locations where access allows	Provide continuous air barrier across soffit openings

3.1003.6c	Option 1: bring soffit inside (seal at top)	Entire opening will be spanned with rigid material in line with the ceiling level Material will be cut to fit and fastened as required	Prevent air leakage from wall to attic Reduce opening to what can be sealed with sealant Ensure closure is permanent and supports any load (e.g., wind, insulation) Bring soffit into thermal boundary
3.1003.6d	Option 2: leave soffit outside (seal at bottom or side)	Each stud bay will be spanned with rigid material will be cut to fit and fastened as required OR Backing at each stud bay will be provided and will be sealed OR Side of stud bays will be sealed with rigid material from bottom of soffit to top-plate OR A sealed rigid barrier will be installed at all transitions	Prevent air leakage from wall to soffit Reduce opening to what can be sealed with sealant Ensure soffit is outside of the thermal boundary
3.1003.6e	Soffits containing non-IC rated recessed lights	Insulation will be kept at least 3" away from the top and side of any fixtures If dropped soffit is to be filled with insulation, then a sealed rigid barrier enclosure will be installed to maintain a 3" clearance around the entire fixture Top of rigid barrier enclosure will be sealed with non-insulating rigid material (e.g., gypsum or equivalent perm rating and R-value)	Prevent light fixture from overheating Bring light fixture inside of the air barrier

3.1004.1 Cathedralized Attic Air Sealing (Insulation Installed at Roof Deck)

Topic: Attics
Subtopic: Cathedralized Attic Ceilings
3.1004.1 Detail Name: Cathedralized Attic Air Sealing (Insulation Installed at Roof Deck)
Desired Outcome: Cathedralized attics sealed to prevent air leakage

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
3.1004.1a	Pre-inspection	An inspection will be conducted for mold, water leaks, and water damage before sealing a cathedralized ceiling Repairs will be completed before work begins	Repair moisture-related issues
3.1004.1b	Backing and infill	Backing or infill will be provided as needed to meet the specific characteristics of the selected material and the characteristics of the open space The infill or backing will not bend, sag, or move once installed	Minimize hole size to ensure successful use of sealant Ensure closure is permanent and supports any load (e.g., wind, insulation) Ensure sealant does not fall out
3.1004.1c	Sealant selection	Sealants will be compatible with their intended surfaces Sealants will allow for differential expansion and contraction between dissimilar materials Sealants will be continuous and meet fire barrier specifications, according to authority having jurisdiction	Select permanent sealant Ensure sealant meets or exceeds the performance characteristics of the surrounding materials

3.1005.1 Tongue and Groove Ceilings

Topic: Attics
Subtopic: Other Ceiling Materials
3.1005.1 Detail Name: Tongue and Groove Ceilings
Desired Outcome: Tongue and groove ceilings sealed to prevent air leakage and moisture movement between the attic and conditioned space

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
3.1005.1a	Pre-inspection	An inspection will be conducted for mold, water leaks, and water damage before sealing a tongue and groove ceiling Repairs will be completed before work	Repair moisture-related issues
3.1005.1b	Backing	Backing will be installed behind tongue and groove ceilings	Prevent air leakage and allow for sealants
3.1005.1c	Sealant selection	Sealants will be compatible with their intended surfaces Sealants will be continuous and meet fire barrier specifications, according to authority having jurisdiction No sealant will be allowed to be visible in the living space	Select permanent sealant Ensure sealant meets or exceeds the performance characteristics of the surrounding materials Ensure ceiling remains aesthetically pleasing

3.1201.1 Double-Hung Wood Windows

Topic: Windows and Doors
Subtopic: Maintenance, Repair, and Sealing
3.1201.1 Detail Name: Double-Hung Wood Windows
Desired Outcome: Windows operable and weather tight; improved energy efficiency performance of fenestration

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
3.1201.1a	Lead paint assessment	Presence of lead-based paint in pre-1978 homes will be assumed unless testing confirms otherwise EPA's Renovation, Repair and Painting (RRP) Program Rule (40 CFR Part 745) in pre-1978 homes and proposed changes to this rule (Federal Register/Vol. 75, No. 87/May 6, 2010) will be complied with, to be superseded by any subsequent final rulemaking or any more stringent state or federal standards	Protect worker and occupant from potential lead hazards
3.1201.1b	Weather stripping	Existing weather stripping and sash sealant will be removed Surface where the sill meets the sash will be cleaned Seal between the fixed components of the window (e.g., jambs, sill) will be continuous and complete while maintaining the operability of the window Continuous and complete weather stripping will be installed on the bottom of the lower sash where it makes contact with the sill and at the top of the upper sash where it makes contact with the upper part of the window frame	Form a complete seal from the outer edge of the sash to the jamb Maintain operability of the window
3.1201.1c	Sash locks	Locks will be installed so that the rails of the upper and lower sashes are flush and in full contact No gaps will be visible between the two sashes Locks will be installed to achieve compression of the two sashes	Form a secure connection between the two sashes
3.1201.1d	Replacement sills	Beveled sill will be flush with interior wall and sloped to the exterior Seams will be continuously and completely sealed with sealant to the jambs and to the frame Sill will be water-sealed and primed	Form a complete seal from the bottom of the lower sash to the sill Maintain operability of the window Allow for drainage to the exterior
3.1201.1e	Sash replacement	Lower sash will have the same bevel on the bottom rail as the sill Sash will be water-sealed and primed	Ensure sash remains in a fixed position when open or partially open Maintain operability of the window

3.1201.1f	Adjust stops	Stops will be adjusted to eliminate visible gaps between the stops and the jamb while maintaining operability of the window	Form a complete seal between the jamb, sash, and stop Maintain operability of the window
3.1201.1g	Replace stops	Stops will be installed to keep the window securely in place Stops will be adjusted to eliminate visible gaps between the stops and the jamb while maintaining operability of the window	Form a complete seal between the jamb, sash, and stop Maintain operability of the window

3.1201.2 Single-Unit Window and Fixed Frame with Wood Sash

Topic: Windows and Doors
Subtopic: Maintenance, Repair, and Sealing
3.1201.2 Detail Name: Single-Unit Window and Fixed Frame with Wood Sash
Desired Outcome: Windows operable and weather tight; improved energy efficiency performance of fenestration

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
3.1201.2a	Lead paint assessment	Presence of lead-based paint in pre-1978 homes will be assumed unless testing confirms otherwise EPA's RRP Program Rule (40 CFR Part 745) in pre-1978 homes and proposed changes to this rule (Federal Register/Vol. 75, No. 87/May 6, 2010) will be complied with, to be superseded by any subsequent final rulemaking or any more stringent state or federal standards	Protect worker and occupant from potential lead hazards
3.1201.2b	Operable windows	All egress windows will be operable as required by local codes	Maintain operability of egress windows
3.1201.2c	Air infiltration	Details that reduce air infiltration will be repaired, replaced, sealed, or installed (e.g., new latch for meeting rail connection, pulley seals, rope caulking for other cracks, interior storm windows) State Energy Conservation Code or local code requirements for air leakage should be met (whichever is more stringent)	Reduce air infiltration
3.1201.2d	Water infiltration	Details that reduce water infiltration will be repaired, replaced, or installed (e.g., replace missing glazing compound on sash, exterior caulking, exterior storm windows)	Reduce water infiltration
3.1201.2e	Occupant education and maintenance	Occupants will be notified of changes or repairs made and will be educated on how to operate and maintain window	Ensure long-term weather tightness

3.1201.3 Exterior Doors

Topic: Windows and Doors
Subtopic: Maintenance, Repair, and Sealing
3.1201.3 Detail Name: Exterior Doors
Desired Outcome: Doors operable and weather tight

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
3.1201.3a	Lead paint assessment	Presence of lead-based paint in pre-1978 homes will be assumed unless testing confirms otherwise EPA's RRP Program Rule (40 CFR Part 745) in pre-1978 homes and proposed changes to this rule (Federal Register/Vol. 75, No. 87/ May 6, 2010) will be complied with, to be superseded by any subsequent final rulemaking or any more stringent state or federal standards	Protect worker and occupant from potential lead hazards
3.1201.3b	Door operation and fit	Door will be adjusted to properly fit the jamb and allow for ease of operation (e.g., hinge replacement, re-plane door, door strike adjustment)	Ensure proper operation of the door
3.1201.3c	Air infiltration	Details that reduce air infiltration will be repaired, replaced, sealed, or installed in accordance with State Energy Conservation Code or local code—whichever is more stringent (e.g., weather stripping, door bottoms, trim replacement with foam)	Reduce air infiltration

3.1201.3d	Water infiltration	Details that reduce water infiltration will be repaired, replaced, sealed, or installed (e.g., adjust threshold, caulk jamb to threshold, caulk trim, flashing)	Reduce water infiltration
3.1201.3e	Occupant education and maintenance	Occupants will be notified of changes or repairs made and will be educated on how to operate and maintain weather stripping and caulk around door and trim	Ensure long-term weather tightness

3.1201.4 Pocket Door

Topic: Windows and Doors
Subtopic: Maintenance, Repair, and Sealing
3.1201.4 Detail Name: Pocket Door
Desired Outcome: Pocket door sealed top and back to prevent leakage

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
3.1201.4a	Backing and infill	Backing or infill will be provided as needed to meet the specific characteristics of the selected material and the characteristics of the hole The infill will not bend, sag, or move once installed	Minimize hole size to ensure successful use of sealant Ensure closure is permanent and supports any load (e.g., wind, insulation) Ensure sealant does not fall out
3.1201.4b	Sealant selection	Sealants will be compatible with their intended surfaces Sealants will allow for differential expansion and contraction between dissimilar materials Sealants will be continuous and meet fire barrier specifications, according to authority having jurisdiction Sealant will be used in accordance with OSHA/manufacturer safety protocol for worker and occupant safety Manufacturer MSDS sheet will be followed for worker safety	Select permanent sealant Ensure sealant meets or exceeds the performance characteristics of the surrounding materials

3.1202.1 Fixed Frame with Wood Sash—Older House

Topic: Windows and Doors
Subtopic: Repairing/Replacing Cracked and Broken Glass
3.1202.1 Detail Name: Fixed Frame with Wood Sash—Older House
Desired Outcome: Glass complete and intact; improved energy efficiency performance of fenestration

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
3.1202.1a	Lead paint assessment	Presence of lead-based paint in pre-1978 homes will be assumed unless testing confirms otherwise EPA's RRP Program Rule (40 CFR Part 745) in pre-1978 homes and proposed changes to this rule (Federal Register/Vol. 75, No. 87/ May 6, 2010) will be complied with, to be superseded by any subsequent final rulemaking or any more stringent state or federal standards	Protect worker and occupant from potential lead hazards
3.1202.1b	Broken glass removal	Putty and push points will be removed Broken or cracked glass will be removed	Safely remove old glass
3.1202.1c	Sash preparation	Opening will be cleaned	Prepare opening for new glass
3.1202.1d	New glass installation	Glass will be sized 1/8" to 3/16" smaller than opening to allow for movement of frame Safety glass will be installed in accordance with local codes Push points will be provided on each side to secure glass in frame Sash will be primed before installing new glass Glazing compound will be added in accordance with manufacturer specifications	Ensure glazing compound will adhere to sash Install, seal, and secure new glass in place Allow glazing compound to harden to ensure secure installation

3.1202.2 Single-Unit Window, Mounted on Rough Opening—Newer House

Topic: Windows and Doors
Subtopic: Repairing/Replacing Cracked and Broken Glass
3.1202.2 Detail Name: Single-Unit Window, Mounted on Rough Opening—Newer House
Desired Outcome: Glass complete and intact; improved energy efficiency performance of fenestration

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
3.1202.2a	Lead paint assessment	Presence of lead-based paint in pre-1978 homes will be assumed unless testing confirms otherwise EPA's RRP Program Rule (40 CFR Part 745) in pre-1978 homes and proposed changes to this rule (Federal Register/Vol. 75, No. 87/May 6, 2010) will be complied with, to be superseded by any subsequent final rulemaking or any more stringent state or federal standards	Protect worker and occupant from potential lead hazards
3.1202.2b	Broken glass removal	Window stops and damaged glass will be removed	Safely remove old glass
3.1202.2c	Opening preparation	Opening will be cleaned Glazing tape will be removed or replaced	Prepare opening for new glass
3.1202.2d	New glass installation	Replacement glass will be sized to original width, height, and depth Stops will be replaced or installed Wood stops will be sealed to glass with appropriate sealant Glass will be selected with comparable tint and coating (color and look) Tempered glass will be installed as required by local codes Glazing compound will be added in accordance with manufacturer specifications	Install, seal, and secure new glass in place Allow glazing compound to harden to ensure secure installation

3.1203.1 Fixed Frame with Wood Sash—Older House

Topic: Windows and Doors
Subtopic: Replacement
3.1203.1 Detail Name: Fixed Frame with Wood Sash—Older House
Desired Outcome: Replacement window provides weather tight fit; improved energy efficiency performance of fenestration

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
3.1203.1a	Lead paint assessment	Presence of lead-based paint in pre-1978 homes will be assumed unless testing confirms otherwise EPA's RRP Program Rule (40 CFR Part 745) in pre-1978 homes and proposed changes to this rule (Federal Register/Vol. 75, No. 87/ May 6, 2010) will be complied with, to be superseded by any subsequent final rulemaking or any more stringent state or federal standards	Protect worker and occupant from potential lead hazards
3.1203.1b	Opening preparation	Interior stops, sashes, parting strips, and pulleys will be removed Opening will be cleaned	Provide a clean opening for replacement window unit
3.1203.1c	Replacement window installation	Replacement window will be installed in accordance with manufacturer specifications, ensuring that the exterior stops are caulked	Ensure replacement window operates properly Ensure replacement window has a weather tight fit
3.1203.1d	Safety	Egress windows and safety glass will be installed in accordance with local codes	Meet all codes when replacing windows
3.1203.1e	Occupant education and maintenance	Occupants will be notified of changes or repairs made and will be educated on how to operate and maintain window	Ensure long-term weather tightness

3.1203.2 Single-Unit Window, Mounted on Rough Opening—Newer House

Topic: Windows and Doors
Subtopic: Replacement
3.1203.2 Detail Name: Single-Unit Window, Mounted on Rough Opening—Newer House
Desired Outcome: Replacement window provides weather tight fit; improved energy efficiency performance of fenestration

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
3.1203.2a	Lead paint assessment	Presence of lead-based paint in pre-1978 homes will be assumed unless testing confirms otherwise EPA's RRP Program Rule (40 CFR Part 745) in pre-1978 homes and proposed changes to this rule (Federal Register/Vol. 75, No. 87/May 6, 2010) will be complied with, to be superseded by any subsequent final rulemaking or any more stringent state or federal standards	Protect worker and occupant from potential lead hazards
3.1203.2b	Opening preparation	Replacement window will be laid out with trim Exterior trim will be removed or exterior siding will be cut back to fit new window with trim Existing window will be removed Window opening will be flashed in accordance with accepted industry standards	Provide a clean and properly flashed opening for replacement window unit
3.1203.2c	Replacement unit preparation	Mounting detail will be determined based on depth of window and location of window liner	Allow for good fit and finish of replacement window
3.1203.2d	Replacement window installation	Replacement windows will be installed in accordance with manufacturer specifications and will be integrated with flashing Gaps between the new window and existing frame will be sealed with low-expanding foam	Ensure replacement window operates properly Ensure replacement window is weather tight
3.1203.2e	Safety	Egress windows and safety glass will be installed in accordance with local codes	Meet all codes when replacing windows
3.1203.2f	Occupant education and maintenance	Occupant will be notified of changes or repairs made and will be educated on how to operate and maintain window	Ensure long-term weather tightness

3.1401.1 Basements Connected to Crawl Spaces—Sealing and Insulating

Topic: Basements and Crawl Spaces
Subtopic: Basements Connected to Crawl Spaces
3.1401.1 Detail Name: Basements Connected to Crawl Spaces—Sealing and Insulating
Desired Outcome: Crawl spaces and basements separated using appropriate methods that define spaces and allow for treatment in accordance with specifications

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
3.1401.1a	Conditioned basements with vented crawl spaces	Crawl space will be separated from the conditioned basement with a continuous air barrier, ground moisture barrier, and thermal boundary	Create separation and define spaces Enable treatment of crawl spaces and basements by referenced specifications Increase house durability and energy efficiency
3.1401.1b	Conditioned basements with closed crawl spaces	Crawl space will be separated from the conditioned basement with a continuous air barrier and ground moisture barrier	Create separation and define spaces Enable treatment of crawl spaces and basements by referenced specifications Increase house durability and energy efficiency
3.1401.1c	Unconditioned basements with vented crawl spaces	Vented crawl space will be separated from the unconditioned basement with a continuous air barrier and ground moisture barrier	Create separation and define spaces Enable treatment of crawl spaces and basements by referenced specifications Increase house durability and energy efficiency
3.1401.1d	Unconditioned basements with closed crawl spaces	Unconditioned basement will be treated as an extension of the closed crawl space	Create separation and define spaces Enable treatment of crawl spaces and basements by referenced specifications Increase house durability and energy efficiency

3.1402.1 Crawl Spaces—Sealing Floor Penetrations

Topic: Basements and Crawl Spaces
Subtopic: Crawl Spaces
3.1402.1 Detail Name: Crawl Spaces—Sealing Floor Penetrations
Desired Outcome: Air leakage prevented and indoor air quality protected

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
3.1402.1a	Backing and infill	Backing or infill will be provided as needed to meet the specific characteristics of the selected sealant and the characteristics of the penetration The backing or infill will not bend, sag, or move once installed	Ensure resulting closure is permanent and supports any load (e.g., insulation) Ensure sealant does not fall out
3.1402.1b	Sealant selection	Sealants will be used to fill holes no larger than recommended by manufacturer specifications Sealants will be compatible with their intended surfaces Sealants will allow for differential expansion and contraction between dissimilar materials Sealants will be continuous and meet fire barrier specifications, according to authority having jurisdiction	Create a permanent seal Ensure sealant meets or exceeds the performance characteristics of the surrounding materials
3.1402.1c	High temperature application	Only non-combustible materials will be used in contact with chimneys, vents, and flues in accordance with authority having jurisdiction	Prevent a fire hazard

3.1402.2 Closed Crawl Spaces—Air Sealing Foundation Vents

Topic: Basements and Crawl Spaces
Subtopic: Crawl Spaces
3.1402.2 Detail Name: Closed Crawl Spaces—Air Sealing Foundation Vents
Desired Outcome: Air and moisture penetration through the existing vent into the crawl space blocked

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
3.1402.2a	Vent closure	Vent opening will be permanently closed and sealed	Prevent air and moisture penetration

3.1402.3 Closed Crawl Spaces—Air Sealing Exterior Wall

Topic: Basements and Crawl Spaces
Subtopic: Crawl Spaces
3.1402.3 Detail Name: Closed Crawl Spaces—Air Sealing Exterior Wall
Desired Outcome: Well-sealed exterior wall prevents leakage and pests

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
3.1402.3a	Seal penetrations	Penetrations will be sealed with a durable material A minimum expected service life of 10 years will be ensured	Prevent air and moisture penetration into crawl space
3.1402.3b	Pest exclusion	If penetration is greater than ¼", a pest-proof material will be used to fill the penetration before sealing	Prevent pest entry

3.1402.4 Closed Crawl Spaces—Air Sealing Brick Curtain Wall with Piers

Topic: Basements and Crawl Spaces
Subtopic: Crawl Spaces
3.1402.4 Detail Name: Closed Crawl Spaces—Air Sealing Brick Curtain Wall with Piers
Desired Outcome: Well-sealed exterior wall prevents leakage and pests

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
3.1402.4a	Seal penetrations	Penetrations will be sealed with a durable material, including the following: • Sealing rain screen to crawl space connection • Re-venting exterior weep holes with wicking rope A minimum expected service life of 10 years will be ensured	Reduce moisture vapor and water from entering the crawl space through the rain screen Decrease probability of rot
3.1402.4b	Pest exclusion	If penetration is greater than ¼", a pest-proof material will be used to fill the penetration before sealing	Prevent pest entry

3.1402.5 Closed Crawl Spaces—Attached Crawl Spaces Under Unconditioned Spaces

Topic: Basements and Crawl Spaces
Subtopic: Crawl Spaces
3.1402.5 Detail Name: Closed Crawl Spaces—Attached Crawl Spaces Under Unconditioned Spaces
Desired Outcome: Closed, attached crawl spaces sealed but accessible

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
3.1402.5a	Separate crawl spaces	A continuous air and vapor barrier between the attached crawl space under unconditioned spaces and the closed crawl space will be maintained	Prevent air and moisture penetration
3.1402.5b	Entry point	Access will be provided to all crawl spaces Access openings through the floor will be a minimum of 18″ by 24″ Openings through a perimeter wall will be not less than 16″ by 24″ When any portion of the through-wall access is below grade, an area way not less than 16″ by 24″ will be provided Under-floor spaces containing appliances will be provided with an unobstructed access large enough to remove the largest appliance but not less than 30″ high and 22″ wide or more than 20′ long measured along the center line of the passageway from the opening to the appliance A level service space at least 30″ deep and 30″ wide will be present at the front or service side of the appliance If the depth of the passageway or the service space exceeds 12″ below the adjoining grade, the walls of the passageway will be lined with concrete or masonry extending 4″ above the adjoining grade in accordance with Chapter 4 2012 IRC The rough-framed access opening dimensions will be a minimum of 22″ by 30″ and large enough to remove the largest appliance	Provide access to attached crawl space for inspections

3.1488.1 Skirting Post and Pier Foundations

Topic: Basements and Crawl Spaces
Subtopic: Special Considerations
3.1488.1 Detail Name: Skirting Post and Pier Foundations
Desired Outcome: Protective skirting effectively installed to retard damage from natural causes such as wind, water, and pests

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
3.1488.1a	Skirting	Any materials making contact with the ground will be rated for ground contact Skirting will be continuous around the perimeter and enclose the entire floor area below the conditioned living space	Minimize pests, wind, water, and freezing of pipes under house
3.1488.1b	Flashing	Skirting will be flashed to prevent the entrance of water	Prevent water from entering space under house
3.1488.1c	Fastening	Entire skirting will be mechanically fastened	Ensure lasting upgrade

3.1501.1 Penetrations, Cracks, and Doors Between Garage and House

Topic: Attached Garages
Subtopic: Garage Openings
3.1501.1 Detail Name: Penetrations, Cracks, and Doors Between Garage and House
Desired Outcome: Openings from garage sealed to prevent leakage

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
3.1501.1a	Penetrations	All lighting fixtures, wiring, plumbing, venting, ducting, and gas piping penetrations will be sealed	Prevent air leakage and pollutant entry
3.1501.1b	Ductwork	All joints and connections in ductwork will be fastened and sealed with UL 181B or 181B-M welds, gaskets, adhesive mastics, or mastic-plus-embedded-fabric systems	Prevent air leakage and pollutant entry
3.1501.1c	Cracks	All cracks in house and garage separation wall will be sealed, including cracks between mud sill, rim joists, subfloors, and bottom of gypsum board, ensuring the air sealing enhances the integrity of the fire resistance construction of that wall All cracks in ceiling surfaces will be sealed	Prevent air leakage and pollutant entry
3.1501.1d	Garage to house door	Weather stripping, door sweep, and threshold will be installed to stop air leakage	Prevent air leakage and pollutant entry
3.1501.1e	Glass	Broken glass panes in doors will be replaced, pointed, and glazed where needed	Prevent air leakage and pollutant entry
3.1501.1f	Carbon monoxide (CO) alarm	CO alarms will be installed in accordance with ASHRAE 62.2, applicable codes and manufacturer specifications	Warn occupants of CO exposure from attached garage
3.1501.1g	Occupant education	Occupant will be educated on need to keep door from garage to house closed and not to warm up vehicles or use any gas engine appliances or grills in the garage, even if the main door is left open	Reduce risk of CO poisoning inside of garage and adjacent rooms

3.1601.1 Preparation and Mechanical Fastening

Topic: Ducts
Subtopic: Duct Preparation
3.1601.1 Detail Name: Preparation and Mechanical Fastening
Desired Outcome: Ducts and plenums properly fastened to prevent leakage

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
3.1601.1a	Preparation	Type and R-value of existing duct insulation (e.g., fiberglass, stone wool, asbestos) will be identified as will the location of vapor retarders, if any If asbestos insulation was used, it will not be disturbed; consult with an asbestos abatement expert for removal Surrounding insulation will be cleared to expose joints being sealed Duct surface to accept sealant will be cleaned Insulation will be returned or replaced with equivalent R-value	Gain access while maintaining insulation value Achieve proper adhesion for airtight seal
3.1601.1b	Metal to metal	Round ducts will be fastened with a minimum of three equally spaced screws Other shaped ducts will be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems, or tapes	Ensure durable joints
3.1601.1c	Flex to metal	Joints will be fastened with tie bands using a tie band tensioning tool	Ensure durable joints
3.1601.1d	Duct board to duct board	Joints will be fastened with clinch stapler	Ensure durable joints
3.1601.1e	Flexible duct to duct board	Metal take-off collar will be used and attached in accordance with 2012 IRC M1601.4.1	Ensure durable joints

3.1601.1f	Metal plenum to air handler cabinet	Plenum will be mechanically fastened	Ensure durable joints
3.1601.1g	Duct board plenum to air handler cabinet	Termination bar or metal strip will be fastened with screws Duct board will be installed between the screw and the termination bar	Ensure durable joints
3.1601.1h	Boot to wood	Screws or nails will be used to fasten boot to wood	Ensure durable joints
3.1601.1i	Boot to gypsum	Boot hanger will be fastened to adjacent framing with screws or nails Boot will be connected to boot hanger with screws Integral snap boots will be installed	Ensure durable joints
3.1601.1j	Flex to duct board	Take-offs will be in accordance with 2012 IRC Chapter 16, 2012 IRC N1103.2, and applicable local code	Ensure durable joints

3.1601.2 Duct Preparation for SPF Application

Topic: Ducts
Subtopic: Duct Preparation
3.1601.2 Detail Name: Duct Preparation for SPF Application
Desired Outcome: Condition of ductwork identified and necessary repairs made in preparation for spray polyurethane foam (SPF) application

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
3.1601.2a	Inspection	All exposed ductwork in unconditioned spaces (e.g., attics, basements, crawl spaces) will be inspected Broken joints or large cracks, gaps, or holes will be identified Type of ductwork (e.g., metal, duct board, flex duct) will be identified Type and R-value of existing duct insulation (e.g., fiberglass, stone wool, asbestos) will be identified as will the location of vapor retarders, if any If asbestos insulation was used, it will not be disturbed; consult with an asbestos abatement expert for removal Loose fitting or damaged fiberglass or stone wool insulation will be removed using proper safety equipment Necessary clearances for installation of SPF will be ensured	Identify damaged ductwork in need of repair Identify type and R-value of existing insulation
3.1601.2b	Repair	Broken or missing ductwork will be repaired or replaced All cracks, gaps, or holes greater than ¼" will be taped or sealed as feasible Dust, dirt, and grease will be removed from exterior surfaces of ducts	Cover openings in ducts to prevent SPF from entering the interior of the duct Ensure surfaces of duct are clean to promote proper adhesion of SPF

3.1601.3 Support

Topic: Ducts
Subtopic: Duct Preparation
3.1601.3 Detail Name: Support
Desired Outcome: Ducts and plenums properly supported

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
3.1601.3a	Support (applies to all duct types)	Flexible and duct board ducts and plenums will be supported every 4' using a minimum of 1 ½" wide material Support materials will be applied in a way that does not crimp ductwork or cause the interior dimensions of the ductwork to be less than specified (e.g., ceiling, framing, strapping); duct support must be installed in accordance with authority having jurisdiction Metal ducts will be supported by 1/2 inch wide eighteen gauge metal straps or 12-gauge galvanized wire at intervals not exceeding 10 feet or other approved means	Eliminate falling and sagging

3.1602.1 Air Sealing Duct System

Topic: Ducts
Subtopic: Duct Sealing
3.1602.1 Detail Name: Air Sealing Duct System
Desired Outcome: Ducts and plenums sealed to prevent leakage

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
3.1602.1a	New component to new component sealant selection	Any closure system used will be in accordance with 2012 IRC Chapter 16	Ensure effectiveness of air sealing system
3.1602.1b	New component to existing component	Seams, cracks, joints, holes, and penetrations less than ¼" will be sealed using fiberglass mesh and mastic Mastic alone will be acceptable for holes less than ¼" that are more than 10' from air handler Seams, cracks, joints, holes, and penetrations between ¼" and ¾" will be sealed in two stages: • They will be backed using temporary tape (e.g., foil tape) as a support prior to sealing • They will be sealed using fiberglass mesh and mastic	Eliminate air leakage into or out of ducts and plenums Ensure adhesion of primary seal (mastic and fiberglass mesh) to the duct Reinforce seal Support mastic and fiberglass mesh during curing
3.1602.1c	Existing component to existing component	Fiberglass mesh and mastic will overlap temporary tape by at least 1" on all sides Fiberglass mesh and mastic will become the primary seal Seams, cracks, joints, holes, and penetrations larger than ¾" will be repaired using rigid duct material Fiberglass mesh and mastic will overlap repair joint by at least 1" on all sides Fiberglass mesh and mastic will be the primary seal	Eliminate air leakage into or out of ducts and plenums Ensure adhesion of primary seal (fiberglass mesh and mastic) to the duct Reinforce seal Support fiberglass mesh and mastic during curing

3.1602.2 Duct Spray Polyurethane Foam Installation

Topic: Ducts
Subtopic: Duct Sealing
3.1602.2 Detail Name: Duct Spray Polyurethane Foam Installation
Desired Outcome: Exposed ductwork in unconditioned spaces insulated and sealed

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
3.1602.2a	Installation	Insulation will be installed according to manufacturer specifications and all provisions of the 2012 IRC SPF will be applied to desired thickness, using pass thickness maximum as indicated by manufacturer Sufficient insulation will be applied to all joints and around all penetrations to the conditioned space through walls, floors, and ceilings SPF will be covered with proper fire protective coverings or coatings appropriate for location of ductwork and type of foam used and provisions of the 2012 IRC and local codes If ducts are used for air-conditioning, an appropriate vapor retarder will be applied on the SPF if open-cell SPF used If 2" or more of closed-cell SPF is used, follow manufacturer specification to determine if additional vapor retarder is needed The flame spread index will not be greater than 25 and the smoke-developed index is not greater than 450 at the specified installed thickness The foam plastic will be protected with an ignition barrier	Insulate and seal all exposed ductwork in unconditioned spaces Manage moisture condensation on ductwork that carry cooled air in warm, moist climates Provide adequate fire protection for exposed SPF

3.1602.3 Proprietary Spray Application

Topic: Ducts
Subtopic: Duct Sealing
3.1602.3 Detail Name: Proprietary Spray Application
Desired Outcome: Ducts and plenums sealed to prevent leakage

For supporting reference material, see Appendix C.

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

3.1602.4 Air Sealing System Components

Topic: Ducts
Subtopic: Duct Sealing
3.1602.4 Detail Name: Air Sealing System Components
Desired Outcome: Ducts and plenums sealed to prevent leakage

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
3.1602.4a	Duct boot to interior surface	All gaps between boot and interior surface will be air sealed Gypsum edge will be wetted before applying water-based sealant Sealants will be continuous and be in accordance with 2012 IRC R302.9	Prevent air leakage Prevent a fire hazard
3.1602.4b	Wooden plenums and building cavities	Accessible connections and joints will be made airtight using approved material	Ensure ducts and plenums will not leak
3.1602.4c	Air handler cabinet	Joints will be closed and cracks and holes not needed for proper function of unit will be sealed using removable sealant (e.g., foil tape) or in accordance with the original equipment manufacturer directions (if available)	Reduce air leakage while maintaining accessibility
3.1602.4d	Filter slot	A pre-manufactured or site manufactured durable filter slot cover will be installed	Reduce air leakage while maintaining accessibility

3.1602.5 Return—Framed Platform

Topic: Ducts
Subtopic: Duct Sealing
3.1602.5 Detail Name: Return— Framed Platform
Desired Outcome: The return duct installed to prevent air leakage

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
3.1602.5a	Preparation	Debris and dirt will be cleaned out of the return platform	Allow for the application of rigid materials and sealants
3.1602.5b	Infill and backing	Backing or infill will be provided as needed to meet the specific characteristics of the selected material and the characteristics of the open space Backing or infill will not bend, sag, or move once installed Material will be rated for use in return duct systems	Minimize hole size to ensure successful use of sealant Ensure closure is permanent and supports any load (e.g., return air pressure) Ensure sealant does not fall out
3.1602.5c	Sealant selection	Sealants will be continuous and be in accordance with 2012 IRC R302.9	Select permanent sealant Ensure sealant meets or exceeds the performance characteristics of the surrounding materials

3.1602.6 Capping Dual-Cooling Up-Ducts

Topic: Ducts
Subtopic: Duct Sealing
3.1602.6 Detail Name: Capping Dual-Cooling Up-Ducts
Desired Outcome: Up-ducts sealed to prevent leakage

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
3.1602.6a	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 A material will be rated for use in duct systems The infill will not bend, sag, or move once installed	Minimize hole size to ensure successful use of sealant Ensure closure is permanent and supports any pressure produced by wind or air handler fan Ensure sealant does not fall out
3.1602.6b	Sealant selection	Sealants will be continuous and be in accordance with 2012 IRC R302.9	Select permanent sealant Ensure sealant meets or exceeds the performance characteristics of the surrounding materials

3.1602.7 Return and Supply Plenums in Basements and Crawl Spaces

Topic: Ducts
Subtopic: Duct Sealing
3.1602.7 Detail Name: Return and Supply Plenums in Basements and Crawl Spaces
Desired Outcome: Connections between the crawl space and living space eliminated to improve indoor air quality (IAQ) and efficiency of the distribution system

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
3.1602.7a	Supply plenums (includes conditioned crawl spaces)	Basements and crawl spaces that are used as heating and cooling supply plenums will not be allowed	Improve IAQ in the living space Eliminate connection between the crawl space and living space Achieve energy impacts
3.1602.7b	Return plenums	Basements and crawl spaces that are used as heating and cooling return plenums will not be allowed	Improve IAQ in the living space Eliminate connection between the crawl space and living space Achieve energy impacts

Section 4: Insulation

4.1001.1 Non-Insulation Contact (IC) Recessed Light

Topic: Attic
Subtopic: General Preparation
4.1001.1 Detail Name: Non-Insulation Contact (IC) Recessed Light
Desired Outcome: Ensure safety from fire and prevent air leakage

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1001.1a	Air barrier system	A fire-rated air barrier system (i.e., equivalent to 5/8 fire code gypsum wallboard) will be used to separate non-IC rated recessed lights from insulation, using one of the methods below: A fire-rated airtight closure taller than surrounding attic insulation will be placed over non-IC rated recessed lights OR The non-IC rated light fixture will be replaced with an airtight and IC-rated fixture	Prevent a fire hazard Prevent air leakage through fixture
4.1001.1b	Enclosure top	The top-fire rated enclosure material will have an R-value of 0.5 or less The top of the enclosure will be left free of insulation	Prevent heat build up
4.1001.1c	Clearance	The entire closure will maintain a 3" clearance between the closure and the fixture including wiring, box, and ballast	Keep an air space around the fixture
4.1001.1d	Sealants and weather stripping	Caulk, mastic, or foam will be used on all edges, gaps, cracks, holes, and penetrations of closure material only	To prevent air leakage, completely adhere the sealant to all surfaces to be sealed

4.1001.2 Knob and Tube Wiring

Topic: Attics
Subtopic: General Preparation
4.1001.2 Detail Name: Knob and Tube Wiring
Desired Outcome: Insulation kept away from contact with live wiring

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

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1001.2a	Identifying knob and tube wiring	Contractor, assessor, auditor, or similar will inspect and assess the house to identify knob and tube wiring	Determine if knob and tube wiring exists
4.1001.2b	Testing to determine if live	Non-contact testing method will be used to identify live wiring	Ensure safety of occupants, workers, and house Plan where remediation is needed
4.1001.2c	Isolate or replace	Live knob and tube will not be covered or surrounded; required by the National Electrical Code (NEC) or authority having jurisdiction A licensed electrical contractor will inspect and certify wiring to be safe and place a warning at all entries to the attic about the presence of knob and tube wiring A dam that does not cover the top will be created to separate insulation from the wire path OR Knob and tube wiring will be replaced with new appropriate wiring by a licensed electrician in accordance with local codes Remaining knob and tube wiring will be rendered inoperable by licensed electrician in accordance with local codes	Ensure work can be completed safely Protect occupant and house Ensure future work can be done safely Prevent the overheating of the wiring

4.1001.3 Fireplace Chimney and Combustion Flue Vents

Topic: Attics
Subtopic: General Preparation
4.1001.3 Detail Name: Fireplace Chimney and Combustion Flue Vents
Desired Outcome: Combustible materials kept away from combustion sources

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1001.3a	Verify attic prep	Holes, penetrations, and bypasses will be sealed Dams will be fixed in places that maintain required clearance	Prevent air leakage Ensure insulation dams maintain clearance
4.1001.3b	Required clearance	A rigid dam having a height greater than the insulation to be installed will be constructed to ensure a 3" clearance between combustion flue vent and dam Chimney vents will have an airspace clearance to combustibles in accordance with 2012 IRC M1801.3.4	Ensure dam material does not bend, move, or sag Prevent a fire hazard
4.1001.3c	Safety	Insulation will not be allowed between a heat-generating appliance and a dam unless material is rated for contact with heat generating sources	Prevent a fire hazard
4.1001.3d	Occupant education	Documentation of material and R-value will be provided to occupant	Provide occupant with documentation of installation

4.1001.4 Vented Eave or Soffit Baffles

Topic: Attics
Subtopic: General Preparation
4.1001.4 Detail Name: Vented Eave or Soffit Baffles
Desired Outcome: Attic ventilation meets code requirements and insulation is protected from wind washing

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1001.4a	Installation	If soffit venting or eave venting is present, baffles will be mechanically fastened to block wind entry into insulation or to prevent insulation from blowing back into the attic If soffit venting or eave venting is present, baffles will be installed to maintain clearance between the roof deck and baffle in accordance with manufacturer specifications Installation will allow for the highest possible R-value above the top plate of the exterior wall	Ensure insulation R-value is not reduced Maintain attic ventilation

4.1001.5 Dense Pack Preparation

Topic: Attics
Subtopic: General Preparation
4.1001.5 Detail Name: Dense Pack Preparation
Desired Outcome: Proper material density achieved safely and cleanly

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1001.5a	Preparation	Lead safety procedures will be followed Cavities will be free of hazards, intact, and able to support dense pack pressures All escape openings will be blocked for material Access will be gained and each cavity will be probed, locating all attic floor joists and blockers Interior will be masked and dust controlled during drilling when accessing from interior Electricity supply will be confirmed and will support blowing machine power demand Blowing machine pressure test will be performed with air on full, feed off, agitator running, and gate closed Hose outlet pressure will be at least 80" of water column (IWC) or 2.9 pounds per square inch (psi) for cellulose insulation; for other types of dense pack insulation, check manufacturer specifications for blowing machine set up	Prevent damage to house Provide thorough access to allow 100% coverage Use proper equipment and process to achieve consistent density, prevent settling, and retard air flow through cavities

4.1001.6 Unvented Roof Deck—Preparation for Spray Polyurethane Foam

Topic: Attics
Subtopic: General Preparation
4.1001.6 Detail Name: Unvented Roof Deck—Preparation for Spray Polyurethane Foam (SPF)
Desired Outcome: Backstop provided to prevent SPF from entering soffit areas

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1001.6a	Surface preparation	Underside of roof deck will be prepared by sealing penetrations Roof deck will be free of contaminants to ensure adhesion of foam	Ensure proper bonding of SPF to substrate surfaces
4.1001.6b	Installation of insulation dams	Dams will be fastened to underside of roof deck and outside edge of exterior wall top plate to prevent SPF insulation from entering soffit area 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 Ensure continuous insulation and air seal of exterior wall top plate and roof deck
4.1001.6c	Elimination of attic venting	All gable vents, ridge vents, and roof vents will be covered with suitable backstop material to provide substrate for SPF application	Remove ventilation points when converting from vented to unvented attic
4.1001.6d	Removal of existing insulation and vapor retarder	All existing attic floor insulation and vapor retarder will be removed	Ensure the new conditioned space is coupled with the house

4.1001.7 Vented Roof Deck—Preparation for SPF

Topic: Attics
Subtopic: General Preparation
4.1001.7 Detail Name: Vented Roof Deck—Preparation for SPF
Desired Outcome: Backstop or substrate provided to prevent SPF from entering soffit areas while ensuring required attic ventilation is provided

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1001.7a	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 20%	Ensure proper bonding of SPF to substrate surfaces
4.1001.7b	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 Vent chutes will penetrate dams as needed	Allow ventilation of underside of roof deck sheathing while creating an unvented, conditioned attic space
4.1001.7c	Installation of insulation dams	Dams will be fastened to underside of roof deck and outside edge of exterior wall top plate to prevent SPF insulation from entering soffit area 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
4.1001.7d	Removal of existing insulation and vapor retarder	All existing attic floor insulation and vapor retarder will be removed	Ensure the new conditioned space is coupled with the house

4.1002.1 Preparation

Topic: Attics
Subtopic: Above Roof Deck Insulation
4.1002.1 Detail Name: Preparation
Desired Outcome: Roof covering removed and replaced to expose roof deck for installation of above roof deck insulation

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1002.1a	Roof covering removal	Existing roof covering will be removed	Expose existing roof deck to prepare for installation of above roof deck insulation
4.1002.1b	Roof covering replacement	New roof covering will be installed in accordance with manufacturer specifications and local building code requirements after installation of above roof deck insulation	Install roof covering correctly Meet local code requirements

4.1002.2 Installation

Topic: Attics
Subtopic: Above Roof Deck Insulation
4.1002.2 Detail Name: Installation
Desired Outcome: Properly installed roof deck insulation

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1002.2a	Sealing	Holes, gaps, and penetrations in existing roof deck will be sealed	Prevent air leaks
4.1002.2b	Installation	Insulation will be installed according to manufacturer specifications without gaps, voids, compressions, misalignments, or wind intrusions Insulation will be installed to prescribed R-value	Install insulation properly
4.1002.2c	Occupant education	Documentation of material and R-value will be provided to occupant	Provide occupant with documentation of installation

4.1003.1 Pitched/Vaulted/Cathedralized Ceilings—Loose Fill Over

Topic: Attics
Subtopic: Attic Ceilings
4.1003.1 Detail Name: Pitched/Vaulted/Cathedralized Ceiling—Loose Fill Over
Desired Outcome: Reduce the rate of heat transfer through cathedral or vaulted ceiling

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1003.1a	Ventilation	Venting will be continuous, if applicable	Ensure capacity to increase R-value while not altering ventilation
4.1003.1b	Lighting	Existence of rated insulation contact can lights, which allow for insulation encapsulation, will be verified Non-insulation contact rated can lights will not be insulated	Prevent a fire hazard

4.1003.1c	Installation	When using cellulose, stabilized product is preferred when available On roof pitches less than 6/12, loose fill cellulose can be used; on roof pitches greater than 6/12, install Insulweb baffles of the same height as the insulation every 6' across slope to prevent the loose fill insulation from sliding downward, or dense pack cellulose above Insulweb stapled to the bottom (underside) of the rafters Loose fill fiberglass will only be used on a slope less than or equal to a 6/12 pitch or the slope application approved by the manufacturer, whichever is less (dense packed fiberglass at slopes greater than 6/12 may be used) Roof cavities will be insulated with loose fill according to manufacturer specifications without gaps, voids, compressions, misalignments, or wind intrusions Insulation will be installed to prescribed R-value	Ensure appropriate material and application Insulate to prescribed R-value
4.1003.1d	Occupant education	Documentation of material and R-value will be provided to occupant	Provide occupant with documentation of installation

4.1003.2 Pitched/Vaulted/Cathedralized Ceilings—Dense Pack Over

Topic: Attics
Subtopic: Attic Ceilings
4.1003.2 Detail Name: Pitched/Vaulted/Cathedralized Ceilings—Dense Pack Over
Desired Outcome: Insulation reduces heat transfer through ceiling and closed attic sections as well as framing cavities inaccessible to other treatments

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1003.2a	Fill slant ceilings	Using fill tube, 100% of each cavity will be filled to a consistent density: • Cellulose material will be installed to a minimum density of 3.5 pounds per cubic foot • Loose fiberglass material will be installed and will be specifically approved for air flow resistance to a minimum density of 2.2 pounds per cubic foot The number of bags installed will be confirmed and will match the number required on the coverage chart Insulation will be verified to prevent visible air movement using chemical smoke at 50 pascals of pressure difference	Ensure complete and consistent coverage throughout ceiling plane Eliminate voids and settling Minimize framing cavity air flows

4.1003.3 Unvented Flat Roof with Existing Insulation

Topic: Attics
Subtopic: Attic Ceilings
4.1003.3 Detail Name: Unvented Flat Roof with Existing Insulation
Desired Outcome: Insulation reduces heat flow through unvented roof

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1003.3a	Ventilation	Code compliant ventilation will be installed before insulation	Reduce possibility of moisture issues
4.1003.3b	Installation	Roof cavities will be blown with loose fill insulation (or roof cavities will be dense packed with insulation) without gaps, voids, compressions, misalignments, or wind intrusions Insulation will be installed to prescribed R-value	Insulate to prescribed R-value
4.1003.3c	Occupant education	Documentation of material and R-value will be provided to occupant	Provide occupant with documentation of installation

4.1003.4 Cape Cod Side Attic Roof—Dense Pack Installation

Topic: Attics
Subtopic: Attic Ceilings
4.1003.4 Detail Name: Cape Cod Side Attic Roof—Dense Pack Installation
Desired Outcome: Consistent, uniform thermal boundary between conditioned and unconditioned space

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1003.4a	Vapor barrier removal	Vapor barriers will be removed from existing attic floor	Ensure the new conditioned space is coupled with the house
4.1003.4b	Netting, fabric, rigid sheathing	When using netting or fabric, staples will be placed every 1 ½" on center, or in accordance with manufacturer specifications, whichever is more stringent Netting or fabric will meet local fire codes Rigid materials will close the cavity	Secure insulation
4.1003.4c	Installation	Roof cavities will be dense packed with loose fill insulation in accordance with manufacturer density specifications Insulation will be installed to prescribed R-value	Insulate to prescribed R-value
4.1003.4d	Onsite documentation	Documentation will be posted as required by federal specification 16 CFR 460	Post documentation onsite to allow verification
4.1003.4e	Occupant education	Documentation of material and R-value will be provided to occupants	Provide occupant with documentation of installation

4.1003.5 Unvented Roof Deck—Spray Polyurethane Foam Installation

Topic: Attics
Subtopic: Attic Ceilings
4.1003.5 Detail Name: Unvented Roof Deck—Spray Polyurethane Foam (SPF) Installation
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 reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1003.5a	Installation	Insulation will be installed to prescribed R-value in accordance with manufacturer specifications SPF will be applied to desired thickness, using pass thickness maximum as indicated by manufacturer, onto roof sheathing between rafters or trusses When desired, underside of rafters or trusses will be covered with SPF to provide layer of continuous insulation Upper vent openings will be covered with SPF, including ridge, roof, and gable that are covered with a substrate In colder climates (IECC Zones 5-8), SPF will be installed to a thickness of least Class II vapor retarder or have at least Class II vapor retarder coating or covering in direct contact with the underside of the SPF	Ensure complete and consistent coverage throughout roof plane Eliminate cracks, gaps, and voids Improve structural integrity of roof deck (closed cell SPF only) Ensure alignment of insulation and air barrier
4.1003.5b	Onsite documentation	Documentation will be posted as required by federal specification 16 CFR 460	Post documentation onsite to allow verification
4.1003.5c	Occupant education	Documentation of material and R-value will be provided to occupant	Provide occupant with documentation of installation

4.1003.6 Vented Roof Deck—Spray Polyurethane Foam Installation

Topic: Attics
Subtopic: Attic Ceilings
4.1003.6 Detail Name: Vented Roof Deck—Spray Polyurethane Foam (SPF) Installation
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 reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1003.6a	Installation	Insulation will be installed at the ceiling level to prescribed R-value in accordance with manufacturer specifications SPF will be applied to desired thickness, using pass thickness maximum as indicated by manufacturer, onto roof sheathing between rafters or trusses In colder climates (IECC Zones 5-8), SPF will be installed to a thickness of least Class II vapor retarder or have at least Class II vapor retarder coating or covering in direct contact with the underside of the SPF	Ensure complete and consistent coverage throughout ceiling plane Eliminate cracks, gaps, and voids Ensure alignment of insulation and air barrier
4.1003.6b	Onsite documentation	Documentation will be posted as required by federal specification 16 CFR 460	Post documentation onsite to allow verification
4.1003.6c	Occupant education	Documentation of material and R-value will be provided to occupant	Provide occupant with documentation of installation

4.1003.7 Ignition and Thermal Barriers—Spray Polyurethane Foam

Topic: Attics
Subtopic: Attic Ceilings
4.1003.7 Detail Name: Ignition and Thermal Barriers—Spray Polyurethane Foam (SPF)
Desired Outcome: Meet building code requirements for fire protection of spray polyurethane foam

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1003.7a	Identify fire safety requirements	Meet or exceed local fire safety requirements for installation of SPF foam Consult local codes to ensure installation complies with fire safety requirements If code requirements are unclear, consult local code officials for clarification	Ensure SPF installed in attic meets fire safety requirements
4.1003.7b	Installation of ignition barrier	If attic is to be used only for the service of utilities, foam will be separated from the attic space using a suitable ignition barrier covering or coating Check manufacturer specifications and/or local codes for appropriate ignition barrier coatings/materials	Protect SPF insulation in the attic to minimize possibility of ignition and combustion
4.1003.7c	Installation of thermal barrier	If attic is to be used for storage or occupancy, spray foam will be separated from the attic space using thermal barrier material (e.g., ½" gypsum wallboard) Consult manufacturer specifications and local codes for approved ignition/thermal barrier, materials, or coatings	Protect SPF insulation in the attic to minimize possibility of ignition and combustion
4.1003.7d	Occupant education	Documentation of ignition or thermal barrier material installation and limitations on attic use, if any, will be provided	Provide occupant with documentation of installation

4.1004.1 Preparation for Dense Packing

Topic: Attics
Subtopic: Knee Walls
4.1004.1 Detail Name: Preparation for Dense Packing
Desired Outcome: Airtight cavity and insulated knee wall

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1004.1a	Backing	All knee walls will have top and bottom plate or blockers installed using rigid materials When knee wall floor and walls are being insulated, the floor joist running under the knee wall will be air sealed If fabric is used before dense packing, it will be secured with 1" crown staples every 2" or with furring strips every wall stud If rigid material is used, material will be installed to cover 100% of the surface of the accessible knee wall area If foam sheathing is used, sheathing will be listed for uncovered use in an attic or covered with a fire barrier	Eliminate bending, sagging, or movement that may result in air leakage Prevent air leakage through the top or bottom of the knee wall Ensure material will not tear under stress from wind loads or insulation
4.1004.1b	Installation	All existing batted insulation will be adjusted to ensure it is in full contact with the interior cladding and the top and bottom plates Insulation that is blown behind fabric or air barrier material will be blown dense to a minimum specification of 3.5 pounds per cubic foot for cellulose Follow manufacturer's requirements for fiberglass dense pack applications	Eliminate misalignment of existing insulation Prevent insulation from settling or moving

4.1004.2 Preparation for Batt Insulation

Topic: Attics
Subtopic: Knee Walls
4.1004.2 Detail Name: Preparation for Batt Insulation
Desired Outcome: Airtight cavity and properly insulated knee wall

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1004.2a	Knee wall prep for batts	All knee walls will have a top and bottom plate or blockers installed using a rigid material All joints, cracks, and penetrations will be sealed in finished material, including interior surface to framing connections	Eliminate bending, sagging, or movement that may result in air leakage Prevent air leakage through the top or bottom of the knee wall Create an air barrier
4.1004.2b	Installation	Insulation will be installed using one of the following methods: • New batts will be installed in accordance with manufacture specifications • All existing batted insulation will be adjusted to ensure it is in full contact with the interior cladding and the top and bottom plates	Eliminate misalignment of existing insulation
4.1004.2c	Backing knee wall	If rigid material is used, material will be installed to cover 100% of the surface of the knee wall If foam sheathing is used, sheathing will be listed for uncovered use in attic, or covered with a fire barrier	Prevent insulation from settling or moving

4.1004.3 Strapping for Existing Insulation

Topic: Attics
Subtopic: Knee Walls
4.1004.3 Detail Name: Strapping for Existing Insulation
Desired Outcome: Consistent, uniform thermal boundary between the conditioned space and unconditioned space to prescribed R-value

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1004.3a	Sealing	Holes and penetrations will be sealed Bypasses will be blocked and sealed	Prevent air leakage
4.1004.3b	Installation	Insulation will be installed in full contact with all sides of existing cavity without gaps, voids, compressions, misalignments, or wind intrusions	Insulate to prescribed R-value
4.1004.3c	Attachment	Strapping material will have a minimum expected service life of 20 years	Maintain alignment
4.1004.3d	Occupant education	Documentation of material and R-value will be provided to occupant	Provide occupant with documentation of installation

4.1004.4 Knee Wall Without Framing

Topic: Attics
Subtopic: Knee Walls
4.1004.4 Detail Name: Knee Wall Without Framing
Desired Outcome: Consistent uniform thermal boundary between the conditioned space and unconditioned space to prescribed R-value

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1004.4a	Sealing	Holes and penetrations will be sealed Bypasses will be blocked and sealed	Prevent air leakage
4.1004.4b	Flat cavity present	Gap between framing and existing air barrier will be insulated	Create a flat insulated surface
4.1004.4c	Installation	A rigid insulated sheathing will be mechanically fastened to code required R-value Seams will be sealed	Insulate to prescribed R-value
4.1004.4d	Occupant education	Documentation of material and R-value will be provided to occupant	Provide occupant with documentation of installation

4.1004.5 Knee Walls and Gable End Walls—Preparation for and Installation of Spray Polyurethane Foam (SPF)

Topic: Attics
Subtopic: Knee Walls
4.1004.5 Detail Name: Knee Walls and Gable End Walls—Preparation for and Installation of SPF
Desired Outcome: Airtight and insulated knee and gable end walls

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1004.5a	Installation of backing	Knee walls will have a top and bottom plate or blockers installed using a rigid material A suitable backstop material attached to the back of the knee wall will be used to support the application of SPF If foam sheathing is used as a backstop, sheathing will be listed for uncovered use in an attic or covered with an ignition barrier, thermal barrier, or approved alternate assembly	Provide a backstop or substrate for application of SPF
4.1004.5b	Installation	Insulation will be installed to prescribed R-value Using SPF application, SPF will be applied to desired thickness onto substrate material from top to bottom plate between studs using pass thickness maximum in accordance with manufacturer specifications In colder climates (IECC Zones 5-8), the SPF will be installed to a thickness of at least Class II vapor retarder or have at least Class II vapor retarder coating or covering in direct contact with the interior of the SPF	Eliminate cracks, gaps, and voids Minimize framing cavity air flows Minimize moisture migration and unwanted condensation in insulation (vapor retarders) Ensure alignment of insulation and air barrier

4.1005.1 Accessible Floors—Batt Installation

Topic: Attics
Subtopic: Attic Floors
4.1005.1 Detail Name: Accessible Floors—Batt Installation
Desired Outcome: Consistent, thermal boundary between conditioned and unconditioned space controls the heat flow

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1005.1a	Preparation	Subfloor or drywall will be removed to access cavities as necessary, including inaccessible knee-wall attic floor spaces All electrical junctions will be flagged to be seen above the level of the insulation Open electrical junction boxes will have covers installed	Access the workspace Provide location of electrical junctions for future servicing Prevent an electrical hazard
4.1005.1b	Installation	Batt insulation will be installed in accordance with manufacturer specifications without gaps, voids, compressions, misalignments, or wind intrusions Insulation will be installed to the prescribed R-value	Insulate to prescribed R-value
4.1005.1c	Occupant education	Documentation of material and R-value will be provided to occupant	Provide occupant with documentation of installation

4.1005.2 Accessible Floors—Loose Fill Installation

Topic: Attics
Subtopic: Attic Floors
4.1005.2 Detail Name: Accessible Floors—Loose Fill Installation
Desired Outcome: Consistent, thermal boundary between conditioned and unconditioned space controls the heat flow

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1005.2a	Preparation	Subfloor or drywall will be removed to access cavities as necessary, including inaccessible knee-wall attic floor spaces Insulation will be adequately marked for depth a minimum of every 300 square feet of attic area, with measurement beginning at the air barrier All electrical boxes will be flagged to be seen above the level of the insulation Open electrical junctions will have covers installed Insulation dams and enclosures will be installed as required	Access the workspace Verify uniformity of insulation material Provide location of electrical boxes for future servicing Prevent an electrical hazard
4.1005.2b	Air barrier	Existence of air barrier material in line with the knee walls will be installed or verified when dense packing Air barrier material will not bend, sag, or move once dense packed	Hold dense pack in place
4.1005.2c	Installation	All insulation will be installed to the depth indicated on the manufacturer coverage chart for desired R-value	Reduce heating and air conditioning costs Improve comfort Minimize noise
4.1005.2d	Onsite documentation	A signed and dated attic card will be provided that includes: • Insulation type • Installed thickness and settled thickness • Coverage area • R-value • Number of bags installed in accordance with manufacturer specifications	Document job completion to contract specifications Confirm amount of insulation installed in attic Ensure ability to match bags required for total area completed

4.1005.3 Accessible Floors—Batt Insulation Over Existing Insulation

Topic: Attics
Subtopic: Attic Floors
4.1005.3 Detail Name: Accessible Floors—Batt Insulation Over Existing Insulation
Desired Outcome: Insulation controls heat transfer through ceiling

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1005.3a	Preparation	Existing insulation will be in contact with the air barrier prior to installing additional insulation on top	Ensure proper performance of insulation
4.1005.3b	Installation	If the top of the existing insulation is below the top of the framing, new batts will be installed parallel with framing members If the top of the existing insulation is above the top of the framing, new batts will be installed perpendicular to framing members	Ensure uniform depth of insulation in continuous contact with existing insulation Eliminate voids and gaps
4.1005.3c	Insulation	Batts will be installed in accordance with manufacturer specifications without gaps, voids, compressions, misalignments, or wind intrusions Insulation will be installed to prescribed R-value	Insulate to prescribed R-value
4.1005.3d	Safety	Insulation will not be allowed on top of non-IC rated can light boxes or between a heat generating appliance and a dam, unless material is rated for contact with heat generating sources	Prevent a fire hazard
4.1005.3e	Occupant education	Documentation of material and R-value will be provided to occupant	Provide occupant with documentation of installation

4.1005.4 Accessible Floors—Loose Fill Over Existing Insulation

Topic: Attics
Subtopic: Attic Floors
4.1005.4 Detail Name: Accessible Floors—Loose Fill Over Existing Insulation
Desired Outcome: Insulation controls heat transfer through ceiling

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1005.4a	Preparation	Existing insulation will be in contact with the air barrier prior to installing additional insulation on top Insulation will be adequately marked for depth a minimum of every 300 square feet of attic area, with measurement beginning at the air barrier All electrical junction boxes will be flagged to be seen above the level of the insulation Open electrical junction boxes will have covers installed Insulation dams and enclosures will be installed as required	Ensure proper performance of insulation Verify uniformity of insulation material Provide location of electrical junctions for future servicing Prevent an electrical hazard
4.1005.4b	Installation	The correct depth and number of bags will be blown in accordance with manufacturer specifications Insulation will be installed to prescribed R-value	Insulate to prescribed R-value
4.1005.4c	Safety	Insulation will not be allowed on top of non-IC rated can light boxes or between a heat-generating appliance and a dam, unless material is rated for contact with heat generating sources	Prevent a fire hazard
4.1005.4d	Onsite documentation	Documentation will be posted as required by federal specification 16 CFR 460	Post documentation onsite to allow verification

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

Topic: Attics
Subtopic: Attic Floors
4.1005.5 Detail Name: Enclosed Bonus Room Floor Over Unconditioned Space—Dense Pack Installation
Desired Outcome: A consistent thermal boundary between conditioned and unconditioned space controls the heat flow

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1005.5a	Air barrier	Existence of air barrier material in line with the knee walls will be installed or verified when dense packing Air barrier material will not bend, sag, or move once dense packed	Hold dense pack in place
4.1005.5b	Fill floors	Each cavity will be 100% filled to consistent density: • Cellulose material will be installed to a minimum density of 3.5 pounds per cubic foot • Loose fiberglass material will be installed and will be specifically approved for air flow resistance to a minimum density of 1.5 to 2 pounds per cubic foot The number of bags installed will be confirmed and will match the number required on the coverage chart Insulation will be verified to prevent visible air movement using chemical smoke at 50 pascals of pressure difference	Eliminate voids and settling Minimize framing cavity air flows
4.1005.5c	Safety	Insulation will not be allowed on top of non-IC rated can light boxes or between a heat-generating appliance and a dam, unless material is rated for contact with heat generating sources	Prevent a fire hazard
4.1005.5d	Onsite documentation	Documentation will be posted as required by federal specification 16 CFR 460	Post documentation onsite to allow verification

4.1005.6 Enclosed Attic Storage Platform Floor—Dense Pack Installation

Topic: Attics
Subtopic: Attic Floors
4.1005.6 Detail Name: Enclosed Attic Storage Platform Floor—Dense Pack Installation
Desired Outcome: Insulation reduces heat flow through floor and framing cavities inaccessible to other treatments

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1005.6a	Fill floors	Each cavity will be 100% filled to consistent density: • Cellulose material will be installed to a minimum density of 3.5 pounds per cubic foot • Loose fiberglass material will be installed and will be specifically approved for air flow resistance to a minimum density of 2.2 pounds per cubic foot The number of bags installed will be confirmed and will match the number required on the coverage chart Insulation will be verified to prevent visible air movement using chemical smoke at 50 pascals of pressure difference	Eliminate voids and settling Minimize framing cavity air flows
4.1005.6b	Safety	Insulation will not be allowed on top of non-IC rated can light boxes or between a heat generating appliance and a dam, unless material is rated for contact with heat generating sources	Prevent a fire hazard
4.1005.6c	Onsite documentation	Documentation will be posted as required by federal specification 16m CFR 460	Post documentation onsite to allow verification

4.1005.7 Attic Floor—Preparation and Installation of Spray Polyurethane Foam (SPF)

Topic: Attics
Subtopic: Attic Floors
4.1005.7 Detail Name: Attic Floor—Preparation and Installation of Spray Polyurethane Foam
Desired Outcome: Consistent, thermal boundary and air barrier between conditioned and unconditioned space controls the heat flow and air leakage

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1005.7a	Preparation	Subfloor or drywall will be removed to access cavities as necessary (e.g., beneath attic knee walls) All electrical junctions will be flagged to be seen above the level of the insulation Open electrical junction boxes will have covers installed	Access the workspace Provide location of electrical junctions for future servicing Prevent an electrical hazard
4.1005.7b	Installation	Insulation will be installed to prescribed R-value SPF will be applied to desired thickness onto attic floor to ceiling material below between attic floor joists using pass thickness maximum as indicated by manufacturer	Insulate to prescribed R-value
4.1005.7c	Safety	Insulation will not be allowed on top of non-IC rated can light boxes or between a heat-generating appliance and a dam, unless material is rated for contact with heat-generating sources	Prevent a fire hazard
4.1005.7d	Onsite documentation	Documentation will be posted as required by federal specification 16 CFR 460 A signed and dated attic card will be provided that includes: • Insulation type • Installed thickness • Coverage area • Insulation R-value	Post documentation onsite to allow verification
4.1005.7e	Occupant education	Documentation of material and R-value will be provided to occupant	Provide occupant with documentation of installation

4.1006.1 Pull-Down Stairs

Topic: Attics
Subtopic: Attic Openings
4.1006.1 Detail Name: Pull-Down Stairs
Desired Outcome: Pull-down attic stair properly sealed and insulated

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1006.1a	Installation	Hatches will be insulated with non-compressible insulation and the measure will include a protective barrier or baffle Pull-down stair assembly will be insulated to the same R-value as the adjoining insulated assembly Pull-down stair rough opening will be surrounded with a durable dam that is higher than the level of the attic floor insulation	Achieve uniform R-value Prevent loose insulation from entering the living area
4.1006.1b	Sealing	Entire pull-down stair assembly will be covered with an airtight and removable/openable enclosure inside the attic space Pull-down stair frame will be caulked, gasketed, weatherstripped, or otherwise sealed with an air barrier material, suitable film, or solid material that allows attic door operation	Prevent air leakage
4.1006.1c	Durability	Completed measure will meet a minimum expected service life of 20 years	Ensure a minimum expected service life
4.1006.1d	Occupant education	The purpose of the entire measure (insulation, air seal, protective barrier, proper attic stair operation) will be communicated to occupant	Educate occupant on how to use the hatch to ensure integrity of insulated and sealed assembly throughout service life

4.1006.2 Access Doors and Hatches

Topic: Attics
Subtopic: Attic Openings
4.1006.2 Detail Name: Access Doors and Hatches
Desired Outcome: Attic access door properly sealed and insulated

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1006.2a	Installation	Access hatches will be insulated with non-compressible insulation to the same R-value as adjoining insulated assembly Attic hatches rough opening will be surrounded with a durable protective baffle that is higher than the level of the surrounding attic floor insulation	Achieve uniform R-value on the attic door or hatch Achieve uniform R-value on the attic floor Prevent loose attic floor insulation from entering the living area
4.1006.2b	Sealing	Access hatch frames will be sealed using caulk, gasket, weatherstrip, or otherwise sealed with an air barrier material, suitable film, or solid material Options will include installing a latch or lock or frictionally engaged components of a pre-fabricated unit above the opening that do not require a latch The measure must include a protective baffle or insulation barrier	Prevent air leakage
4.1006.2c	Attachment	Insulation will be permanently attached and in complete contact with the air barrier	Insulate to prescribed R-value
4.1006.2d	Durability	Completed measure will meet a minimum expected service life of 20 years	Ensure a minimum expected service life
4.1006.2e	Occupant education	Purpose of insulation and proper hatch operation will be communicated to occupant	Educate occupant on how to use the hatch to ensure integrity of insulated and sealed assembly throughout service life

4.1006.3 Whole-House Fan

Topic: Attics
Subtopic: Attic Openings
4.1006.3 Detail Name: Whole-House Fan
Desired Outcome: Consistent, uniform thermal boundary between the conditioned space and unconditioned space to prescribed R-value of an adjoining insulated assembly

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1006.3a	Installation	Sides of fan insulation box assembly will be insulated to the same R-value as adjoining insulated assembly	Insulate to prescribed R-value
4.1006.3b	Air sealing	Fan insulation box frame will be continuously weatherstripped to ensure a tight fit Fan insulation box will be constructed at a depth to protect the fan housing and motor from insulation	Prevent air leakage
4.1006.3c	Attachment	Non-compressible insulation will be permanently attached in contact with fan insulation box Appropriate adhesive or mechanical fastener will be used	Ensure continuous alignment with air barrier
4.1006.3d	Durability	Material integrity will meet a minimum expected service life of 20 years	Ensure a minimum expected service life
4.1006.3e	Occupant education	Purpose of insulation will be communicated to occupant	Educate occupant on how to use the whole-house fan to ensure integrity of the fan insulated assembly throughout service life

4.1088.1 Attic Ventilation

Topic: Attics
Subtopic: Special Considerations
4.1088.1 Detail Name: Attic Ventilation
Desired Outcome: Properly restored vents minimize moisture and ice dams

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1088.1a	Air barrier and thermal boundary	Attic ventilation will be recommended or installed after: • The presence of an effective air barrier and thermal boundary between the attic and the living space is verified • Appropriate attic sealing and proper insulation is specified as part of the scope of work • Local code requires attic ventilation during weatherization or retrofits	Ensure presence of continuous air barrier and thermal boundary
4.1088.1b	Vent type	Attic vent types will be made of corrosion-resistant material for their specific location (e.g., exterior soffit, gable end, roof) and material and intended use (e.g., metal vent on metal roof) Attic-powered ventilators will not be used	Ensure vent meets proper performance characteristics for location and roofing type
4.1088.1c	Vent location	Placement of attic vents will be considered for proper air flow and prevention of entry of wind driven rain or snow	Encourage proper air flow Minimize entry of wind driven rain or snow
4.1088.1d	Ventilation baffling	Baffling for attic soffit vents will be installed to: • Ensure proper air flow • Prevent wind washing of insulation • Allow maximum insulation coverage • Ensure baffle terminates above insulation	Ensure vent allows proper air flow without compromising insulation performance
4.1088.1e	Ventilation screens	All attic ventilation will have screens with non-corroding wire mesh with openings of 1/16" to 1/4" to prevent pest entry (e.g., birds, bats, bees) Existing vents that are not screened will be covered with non-corroding wire mesh with openings of 1/16" to 1/4" Ensure net free area requirements are met Additional vents or larger vents can be added if screen size is smaller than designated	Prevent pest entry

4.1088.2 Radiant Barrier

Topic: Attics
Subtopic: Special Considerations
4.1088.2 Detail Name: Radiant Barrier
Desired Outcome: Radiant heat flow reduced

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1088.2a	Stapling	An air space no less than ¾" will be maintained between the barrier and the bottom of the roof deck	Ensure performance of radiant barrier
4.1088.2b	Ventilation	A minimum of 3" clearance from soffit vents and ridge vents will be maintained	Allow for air flow behind barrier
4.1088.2c	Gable walls	Radiant barrier will apply to gable walls while maintaining a ¾" air space Radiant barrier will not block gable vents	Ensure performance of radiant barrier
4.1088.2d	Porch and garage attic spaces	Radiant barrier will be installed to separate the attic above conditioned space from adjacent attics Radiant barrier will be installed to withstand local wind loads	Reduce radiant heat entry Ensure durability

4.1088.3 Skylights

Topic: Attics
Subtopic: Special Considerations
4.1088.3 Detail Name: Skylights
Desired Outcome: Consistent, uniform thermal boundary between the conditioned space and unconditioned space to prescribed R-value

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1088.3a	Sealing	Holes and penetrations will be sealed Bypasses will be blocked and sealed	Prevent air leakage
4.1088.3b	Installation	Insulation will be installed in accordance with manufacturer specifications and will be in full contact with all sides of existing cavity without gaps, voids, compressions, misalignments, or wind intrusions Insulation will be installed to prescribed R-value	Insulate to prescribed R-value
4.1088.3c	Occupant education	Documentation of material and R-value will be provided to occupant	Provide occupant with documentation of installation

4.1088.4 Parapet Walls—Dense Pack

Topic: Attics
Subtopic: Special Considerations
4.1088.4 Detail Name: Parapet Walls—Dense Pack
Desired Outcome: Properly installed insulation reduces heat flow through parapet wall

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1088.4a	Access	Proper access in wall exterior or interior containment area will be ensured Lead safety procedures in houses built before 1978 will be followed in accordance with EPA - Healthy Indoor Environment Protocols for Home Energy Upgrades	Protect worker and occupant health
4.1088.4b	Installation	Dense pack insulation will be installed in accordance with manufacturer specifications at void area	Seal wall

4.1088.5 Parapet Walls—Spray Polyurethane Foam (SPF)

Topic: Attics
Subtopic: Special Considerations
4.1088.5 Detail Name: Parapet Walls—SPF
Desired Outcome: Properly installed insulation reduces heat flow through parapet wall

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1088.5a	Access	Proper access in wall exterior or interior containment area will be ensured Lead safety procedures in houses built before 1978 will be followed in accordance with EPA – Healthy Indoor Environment Protocols for Home Energy Upgrades	Protect worker and occupant health
4.1088.5b	Installation	SPF insulation will be installed in accordance with manufacturer specifications at void area	Seal and insulate wall

4.1101.1 Exterior Wall Dense Packing

Topic: Walls
Subtopic: Preparation
4.1101.1 Detail Name: Exterior Wall Dense Packing
Desired Outcome: Walls properly prepared to receive dense pack insulation

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1101.1a	Preparation	Lead and asbestos safety procedures will be followed Cavities will be free of hazards, intact, and able to support dense pack pressures Drilling hazards (e.g., wiring, venting, fuel piping) will be located Blocking will be installed around: • All openings to inside crawl space and basement for fibrous material • High temperature fire-rated materials • Wiring and electrical hazards • Heat sources Access to exterior wall cavities will be gained, sheathing will be drilled as needed and probed to locate each cavity, wall studs, and blockers Interior will be masked and dust controlled during drilling when accessing from interior Electricity supply will be confirmed and will support blowing machine power demand Blowing machine pressure test will be performed with air on full, feed off, agitator running, and gate closed Hose outlet pressure will be at least 80 IWC or 2.9 psi for cellulose insulation; for other types of dense pack insulation, check manufacturer specification for blowing machine set up	Prevent damage to house Provide a clean work space Provide thorough access to allow 100% coverage Ensure proper equipment and process results in consistent density Prevent settling and retard air flow through cavities Protect worker and occupant health
4.1101.1b	Exterior dense pack	Using fill tube, 100% of each cavity will be filled to a consistent density: • Cellulose material will be installed to a minimum density of 3.5 pounds per cubic foot • Loose fiber glass material will be installed and will be specifically approved for air flow resistance to a minimum density of 1.5 to 2 pounds per cubic foot The number of bags installed will be confirmed and will match the number required on the coverage chart Insulation density will be verified by bag count, core sampling, or infrared camera with the blower door at 50 pascals to prevent visible air movement using chemical smoke at 50 pascals of pressure difference	Eliminate voids and settling Minimize framing cavity air flows

4.1101.2 Exterior Wall Insulating Sheathing

Topic: Walls
Subtopic: Preparation
4.1101.2 Detail Name: Exterior Wall Insulating Sheathing
Desired Outcome: Wall cladding removed and replaced to expose wall sheathing for installation of insulating wall sheathing

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1101.2a	Wall cladding removal	Existing cladding will be removed Lead and asbestos safety procedures will be followed	Expose existing wall sheathing to prepare for installation of insulating sheathing
4.1101.2b	Wall cladding replacement	New cladding will be installed in accordance with manufacturer specifications and local codes after exterior wall insulation is installed	Install wall cladding correctly Meet local codes

4.1101.3 Exterior Wall Spray Polyurethane Foam (SPF)—Masking and Surface Preparation

Topic: Walls
Subtopic: Preparation
4.1101.3 Detail Name: Exterior Wall Spray Polyurethane Foam—Masking and Surface Preparation
Desired Outcome: Finished surfaces are protected and SPF has a suitable surface to adhere to

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1101.3a	Surface protection	Finished surfaces that should not be covered with SPF (e.g., windows, doors) will be identified Surfaces will be covered or sealed with appropriate material (e.g., plastic film, masking tape) to protect from SPF overspray	Prevent overspray and potential damage to finished surfaces
4.1101.3b	Substrate repair	Cracks, gaps, and holes in the substrate will be covered or sealed in accordance with manufacturer specifications with appropriate material	Prevent waste of SPF Prevent overspray into adjacent areas
4.1101.3c	Substrate cleaning	All surfaces where SPF is applied will be clean, dry, and free of contamination and degradation Substrate surfaces will be wiped, blown, or vacuumed to be free of excessive dust and dirt Grease and oil will be removed using appropriate cleaners or solvents Moisture content of all wood substrate materials will be checked to ensure it is below 20%	Ensure proper bonding of SPF to substrate surfaces

4.1101.4 Exterior Wall Spray Polyurethane Foam (SPF)—Electrical System Considerations

Topic: Walls
Subtopic: Preparation
4.1101.4 Detail Name: Exterior Wall Spray Polyurethane Foam—Electrical System Considerations
Desired Outcome: Outlet, junction, switch, and light fixture boxes and existing wiring are protected from SPF

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1101.4a	Box protection	All front and back openings of all outlet, switch, and light fixture boxes will be covered with masking tape All electrical junction boxes will be accessible after the installation of SPF Open electrical junction boxes will have covers installed	Prevent SPF from covering any switches and outlets and from entering the inside of any electrical box

4.1102.1 Open Wall Insulation—General

Topic: Walls
Subtopic: Accessible Walls
4.1102.1 Detail Name: Open Wall Insulation—General
Desired Outcome: Consistent, uniform thermal boundary between the conditioned space and unconditioned space to prescribed R-value

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1102.1a	Sealing	Holes and penetrations will be sealed Bypasses will be blocked and sealed	Prevent air leakage
4.1102.1b	Installation	Insulation will be installed in accordance with manufacturer specifications without gaps, voids, compressions, misalignments, or wind intrusions Insulation will be installed to prescribed R-value	Insulate to prescribed R-value
4.1102.1c	Pre-drywall verification	Verification of complete installation without gaps, voids, compressions, misalignments, or wind intrusions will be provided	Install insulation correctly
4.1102.1d	Occupant education	Documentation of material and R-value will be provided to occupant	Provide occupant with documentation of installation

4.1102.2 Open Wall—Spray Polyurethane Foam (SPF) Installation

Topic: Walls
Subtopic: Accessible Walls
4.1102.2 Detail Name: Open Wall—Spray Polyurethane Foam Installation
Desired Outcome: Exterior walls are insulated and sealed

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1102.2a	Installation	Interior cladding or interior finish material will be removed on areas to be insulated SPF will be applied to desired thickness, using pass thickness maximum as indicated by manufacturer SPF will be applied onto exterior sheathing or interior finish materials between studs and top/bottom plates	Insulate and seal exterior walls
4.1102.2b	Vapor retarders	If vapor retarder is needed, it will be applied in proper location In colder climates (IECC Zones 5-8), the SPF used will be installed to a thickness of at least Class II vapor retarder or have at least Class II vapor retarder coating or covering in direct contact with the inside surface of the SPF	Minimize water vapor condensation in walls
4.1102.2c	Fire protection	SPF will be separated from the occupied interior spaces of the building with a thermal barrier (typically ½" or thicker gypsum wallboard or approved alternate assembly) Check local codes for fire protection requirements	Provide necessary fire protection for combustible SPF insulation

4.1103.1 Dense Pack Exterior Walls

Topic: Walls
Subtopic: Enclosed Walls
4.1103.1 Detail Name: Dense Pack Exterior Walls
Desired Outcome: Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1103.1a	Exterior dense pack	Using fill tube, 100% of each cavity will be filled to a consistent density: • Cellulose insulation used in an enclosed cavity will be installed at 3.5 pounds per cubic foot or greater density • Blown fiberglass, mineral fiber, or rock and slag wool used in an enclosed cavity will be installed at or above the manufacturer recommended density to limit air flow that corresponds to an air permeance value of 3.5 cfm/sq. ft. at 50 pascals, as measured using BPI- 102 "Standard for Air Resistance of Thermal Insulation Used in Retrofit Cavity Applications – Material Specification" or ASTM C 522, E 283, or E 2178; the number of bags installed will be confirmed and will match the number required on the coverage chart Insulation will be verified to prevent visible air movement using chemical smoke at 50 pascals of pressure difference	Eliminate voids and settling Minimize framing cavity air flows

4.1103.2 Additional Exterior Wall Cavities

Topic: Walls
Subtopic: Enclosed Walls
4.1103.2 Detail Name: Additional Exterior Wall Cavities
Desired Outcome: Properly installed insulation reduces heat flow through walls and framing cavities inaccessible to other treatments

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1103.2a	Location of cavities	Details remaining in or between completed wall sections will be located and accessed	Ensure the last gaps and framing edges in the thermal boundary, roof-wall joints, floor-wall joints, etc., are found and finished
4.1103.2b	Sealing	Backing will be provided and all newly uncovered openings will be sealed with air barriers, foam, or mastic, maintaining all required clearances	Ensure the air barrier is connected across all accessible house elements
4.1103.2c	Dense packing	Using fill tube, 100% of each cavity will be filled to a consistent density: • Cellulose insulation used in an enclosed cavity will be installed at 3.5 pounds per cubic foot or greater density • Blown fiberglass, mineral fiber, or rock and slag wool used in an enclosed cavity will be installed at or above the manufacturer recommended density to limit airflow that corresponds to an air permeance value of 3.5 cfm/sq. ft. at 50 pascals, as measured using BPI-102 "Standard for Air Resistance of Thermal Insulation Used in Retrofit Cavity Applications—Material Specification" or ASTM C 522, E 283, or E 2178; the number of bags installed will be confirmed and will match the number required on the coverage chart Insulation will be verified to prevent visible air movement using chemical smoke at 50 pascals of pressure difference	Eliminate voids and settling Minimize framing cavity air flows

4.1103.2d	Quality assurance	Completed wall sections will be viewed using infrared camera with blower door operating Any voids or low density areas will be drilled and re-packed	Establish air barrier and thermal boundary Confirm no voids or hidden air flows remain
4.1103.2e	Close holes	Installation holes will be plugged as follows: • Exterior holes will be weather barrier patched • Interior holes will be coated and patched to match original interior surface All construction debris and dust will be collected and removed	Ensure house is returned to watertight and clean condition

4.1103.3 Insulated Sheathing and Insulated Siding Installation

Topic: Walls
Subtopic: Enclosed Walls
4.1103.3 Detail Name: Insulated Sheathing and Insulated Siding Installation
Desired Outcome: Properly installed insulated wall sheathing and insulated siding

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1103.3a	Sealing	Holes, gaps, and penetrations in existing sheathing will be sealed	Prevent air leaks
4.1103.3b	Location of wall framing	Wall studs and other framing will be located and marked	Provide secure attachment of insulating sheathing
4.1103.3c	Installation	Insulation will be installed in accordance with manufacturer specifications without gaps, voids, compressions, misalignments, or wind intrusions Insulation will be installed to prescribed R-value	Install insulation properly
4.1103.3d	Occupant education	Documentation of material and R-value will be provided to occupant	Provide occupant with documentation of installation

4.1301.1 Standard Floor System—Batt Installation

Topic: Floors
Subtopic: Accessible Floors
4.1301.1 Detail Name: Standard Floor System—Batt Installation
Desired Outcome: Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1301.1a	Sealing	Sealing the floor system will be completed before insulating	Ensure airtight envelope Prevent leakage
4.1301.1b	Installation	Insulation will be installed in contact with subfloor without gaps, voids, compressions, misalignments, or wind intrusions If kraft-faced batts are used, they will be installed with kraft facing to subfloor Insulation will be installed to prescribed R-value	Insulate to prescribed R-value
4.1301.1c	Securing batts	Batts will be secured with physical fasteners	Ensure insulation remains in contact with subfloor
4.1301.1d	Occupant education	Documentation of material and R-value will be provided to occupant	Provide occupant with documentation of installation

4.1301.2 Standard Floor System—Loose Fill with Netting

Topic: Floors
Subtopic: Accessible Floors
4.1301.2 Detail Name: Standard Floor System—Loose Fill with Netting
Desired Outcome: Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1301.2a	Sealing	Sealing the floor system will be completed before insulating	Ensure airtight envelope Prevent leakage
4.1301.2b	Netting, fabric	When using netting or fabric, staples will be placed every 1 ½″ on center Netting or fabric will meet local fire codes	Secure insulation
4.1301.2c	Installation	Insulation in netted or fabric cavities will be dense packed with loose fill insulation in accordance with manufacturer specifications Insulation will be installed to prescribed R-value Insulation will be in continuous contact with air barrier	Insulate to prescribed R-value Ensure a continuous thermal boundary between conditioned and unconditioned space
4.1301.2d	Occupant education	Documentation of material and R-value will be provided to occupant	Provide occupant with documentation of installation

4.1301.3 Standard Floor System—Loose Fill with Rigid Barrier

Topic: Floors
Subtopic: Accessible Floors
4.1301.3 Detail Name: Standard Floor System—Loose Fill with Rigid Barrier
Desired Outcome: Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1301.3a	Sealing	Sealing the floor system will be completed before insulating	Ensure airtight envelope Prevent leakage
4.1301.3b	Rigid air barrier	A rigid air barrier will be mechanically fastened to underside of floor assembly, providing 100% coverage of the floor assembly Seams and penetrations will be sealed	Relocate air barrier
4.1301.3c	Installation	Loose fill insulation will be installed between air barrier and subfloor according to manufacturer specifications Insulation will be installed to prescribed R-value	Insulate to prescribed R-value
4.1301.3d	Occupant education	Documentation of material and R-value will be provided to occupant	Provide occupant with documentation of installation

4.1301.4 Dense Pack Floor System with Rigid Barrier

Topic: Floors
Subtopic: Accessible Floors
4.1301.4 Detail Name: Dense Pack Floor System with Rigid Barrier
Desired Outcome: Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1301.4a	Sealing	Sealing the floor system will be completed before insulating	Ensure airtight envelope Prevent leakage
4.1301.4b	Rigid air barrier	A rigid air barrier will be mechanically fastened to underside of floor assembly, providing 100% coverage of the floor assembly Seams and penetrations will be sealed	Relocate air barrier
4.1301.4c	Installation	Dense pack insulation will be installed between air barrier and subfloor according to manufacturer specifications Insulation will be installed to prescribed R-value	Insulate to prescribed R-value
4.1301.4d	Occupant education	Documentation of material and R-value will be provided to occupant	Provide occupant with documentation of installation

4.1301.5 Cantilevered Floor—Batt Installation

Topic: Floors
Subtopic: Accessible Floors
4.1301.5 Detail Name: Cantilevered Floor—Batt Installation
Desired Outcome: Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1301.5a	Air barrier	Air barrier will be installed between joists and sealed Air barrier will be placed to the most interior edge of the top plate of the wall below	Separate cantilevered floor from conditioned floor space Allow for insulation
4.1301.5b	Installation	Air barrier will be insulated between joist from top plate of the wall below to subfloor above Cantilevered subfloor will be insulated in complete contact with the floor without gaps, voids, compressions, misalignments, or wind intrusions If kraft-faced batts are used, they will be installed with kraft facing to the air barrier Insulation will be installed to prescribed R-value	Insulate to prescribed R-value
4.1301.5c	Attachment	Batts will be secured with physical fasteners	Ensure insulation remains in contact with subfloor and air barrier
4.1301.5d	Exterior soffit	Exterior soffit material will be installed and sealed	Cover and protect insulation
4.1301.5e	Occupant education	Documentation of material and R-value will be provided to occupant	Provide occupant with documentation of installation

4.1301.6 Pier Construction Subfloor Insulation—Batt Installation with Rigid Barrier

Topic: Floors
Subtopic: Accessible Floors
4.1301.6 Detail Name: Pier House Subfloor Insulation—Batt Installation with Rigid Barrier
Desired Outcome: Consistent, uniform thermal barrier between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1301.6a	Subfloor preparation	Sealing between house and crawl space will be completed before insulating	Ensure airtight envelope Prevent leakage
4.1301.6b	Installation	Insulation will be installed in contact with subfloor without gaps, voids, compressions, misalignments, or wind intrusions If kraft-faced batts are used, they will be installed with kraft facing to subfloor Insulation will be installed to prescribed R-value	Insulate to prescribed R-value
4.1301.6c	Secure batts	Batts will be secured with physical fasteners	Ensure insulation remains in contact with subfloor
4.1301.6d	Rigid air barrier	A rigid air barrier will be mechanically fastened to underside of floor assembly Seams and penetrations will be sealed	Protect insulation
4.1301.6e	Occupant education	Documentation of material and R-value will be provided to occupant	Provide occupant with documentation of installation

4.1301.7 Pier Construction Subfloor Insulation—Loose Fill with Rigid Barrier

Topic: Floors
Subtopic: Accessible Floors
4.1301.7 Detail Name: Pier House Subfloor Insulation—Loose Fill with Rigid Barrier
Desired Outcome: Consistent, uniform thermal barrier between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1301.7a	Subfloor preparation	Sealing between house and crawl space will be completed before insulating	Prevent air leakage
4.1301.7b	Rigid air barrier	A rigid air barrier will be mechanically fastened to underside of floor assembly, providing 100% coverage of the floor assembly Seams and penetrations will be sealed	Relocate air barrier
4.1301.7c	Installation	Loose fill insulation will be installed between air barrier and subfloor according to manufacturer specifications Insulation will be installed to prescribed R-value	Insulate to prescribed R-value
4.1301.7d	Occupant education	Documentation of material and R-value will be provided to occupant	Provide occupant with documentation of installation

4.1301.8 Pier Construction Subfloor Installation—Dense Pack with Rigid Barrier

Topic: Floors
Subtopic: Accessible Floors
4.1301.8 Detail Name: Pier House Subfloor Installation—Dense Pack with Rigid Barrier
Desired Outcome: Consistent, uniform thermal barrier between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1301.8a	Subfloor preparation	Sealing between house and crawl space will be completed before insulating	Prevent air leakage
4.1301.8b	Rigid air barrier	A rigid air barrier will be mechanically fastened to underside of floor assembly, providing 100% coverage of the floor assembly Seams and penetrations will be sealed	Relocate air barrier
4.1301.8c	Installation	Dense pack insulation will be installed between air barrier and subfloor according to manufacturer specifications Insulation will be installed to prescribed R-value	Insulate to prescribed R-value
4.1301.8d	Occupant education	Documentation of material and R-value will be provided to occupant	Provide occupant with documentation of installation

4.1301.9 Open Floors Over Unconditioned Space and Cantilevered Floors, Floors Over Garages, Floors Over Unconditioned Crawl Spaces—Spray Polyurethane Foam (SPF) Installation

Topic: Floors
Subtopic: Accessible Floors
4.1301.9 Detail Name: Open Floors Over Unconditioned Space and, Cantilevered Floors, Floors Over Garages, Floors Over Unconditioned Crawl Spaces—Spray Polyurethane Foam Installation
Desired Outcome: Floors over unconditioned spaces (e.g., basements, garages) insulated and sealed

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1301.9a	Preparation	All floor areas will be open and accessible for SPF application Cracks, gaps, and holes will be covered or sealed per manufacturer guidelines with appropriate material Insulation dams or end blockers will be installed where needed All surfaces where SPF is applied will be clean, dry, and free of contamination and degradation Substrate surfaces will be wiped, blown, or vacuumed to be free of excessive dust and dirt Grease and oil will be removed using appropriate cleaners or solvents Moisture content of all wood substrate materials will be checked to ensure it is below 20%	Prepare all substrate surfaces for the application of SPF
4.1301.9b	Installation	Insulation will be installed to prescribed R-value according to manufacturer specifications SPF will be applied to desired thickness, using pass thickness maximum as indicated by manufacturer, onto subfloor between floor joists and all rim/band joists When desired, underside of joists will be covered with SPF to provide layer of continuous insulation	Insulate and seal floors
4.1301.9c	Fire protection	SPF will be separated from the interior occupied space of the building with a 15-minute thermal barrier (typically ½" or thicker gypsum wallboard or approved ignition barrier coating) Check local codes for fire protection requirements	Provide necessary fire protection for combustible SPF insulation

4.1401.1 Band/Rim Joists—Spray Polyurethane Foam (SPF) Installation

Topic: Basements and Crawl Spaces
Subtopic: Band/Rim Joists
4.1401.1 Detail Name: Band/Rim Joists—Spray Polyurethane Foam Installation
Desired Outcome: Insulate and seal all band/rim joist areas between subfloor and foundation or top plate of wall below

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1401.1a	Preparation	All band/rim joist areas will be open and accessible for SPF application All surfaces where SPF is applied will be clean, dry, and free of contamination and degradation Substrate surfaces will be wiped, blown, or vacuumed to be free of excessive dust and dirt Grease and oil will be removed using appropriate cleaners or solvents Moisture content of all wood substrate materials will be checked to ensure it is below 20%	Prepare all substrate surfaces for the application of SPF
4.1401.1b	Installation	SPF will be applied to desired thickness, using pass thickness maximum in accordance with manufacturer specifications, onto subfloor between floor joists and all rim/band joists When applied to first floor, SPF will be continuous from subfloor surface, over band/rim joist and sill plate, and in contact with foundation below When applied to second story floor or above, SPF will be continuous from subfloor surface, over band/rim joist, and in contact with top plate below	Insulate and seal floors
4.1401.1c	Fire protection	If SPF exceeds a thickness of 3", all SPF will be separated from the occupied interior space of the building with an approved thermal barrier material (typically ½" or thicker gypsum wallboard or an approved thermal barrier coating) Application to rim/band joist up to 3" can be left exposed if the foam is Class I Local codes will be confirmed and followed for fire protection requirements	Provide necessary fire protection for combustible SPF insulation

4.1402.1 Closed Crawl Spaces—Wall Insulation

Topic: Basements and Crawl Spaces
Subtopic: Basements and Crawl Space Walls
4.1402.1 Detail Name: Closed Crawl Spaces—Wall Insulation
Desired Outcome: Closed crawl spaces insulated to achieve best thermal performance possible

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1402.1a	Insulation selection	A non-absorbent, fire-rated insulation will be used with a minimum life expectancy of 10 years	Improve thermal performance
4.1402.1b	R-value	Regional International Energy Conservation Code (IECC) will be followed for required R-values	Improve thermal performance
4.1402.1c	Termite inspection gap	Where termite pressure exists, a 3" inspection gap will be maintained from the top of the insulation to the bottom of any wood	Allow for termite detection
4.1402.1d	Attachment	Insulation will be attached with a durable connection equal to or better than manufacturer specifications, whichever is more durable A minimum expected service life of 10 years will be ensured	Maintain insulation performance without compromising the air or vapor barrier

4.1402.1e	Band joist and wood foundation walls	A vapor-diffuse insulation will be installed Where termite pressure exists, removable band joist insulation will be installed	Improve thermal performance Allow for termite inspection and drying of wood materials
4.1402.1f	Band joist and wood foundation walls (cold climates)	Insulation will be installed with a vapor barrier on the warm side of the insulation Where termite pressure exists, removable band joist insulation will be installed	Improve thermal performance Prevent moisture condensation on the inside of the band joist or wood walls Allow for termite inspection and drying of wood materials

4.1402.2 Basement Wall Insulation—No Ground Water Leakage

Topic: Basements and Crawl Spaces
Subtopic: Basement and Crawl Space Walls
4.1402.2 Detail Name: Basement Wall Insulation—No Ground Water Leakage
Desired Outcome: Basement insulation improves thermal performance and ensures sufficient drying potential

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1402.2a	R-value	Regional IECC will be followed for required R-values	Improve thermal performance of the basement and living space
4.1402.2b	Air barrier	A continuous air barrier will be installed on the warm side of the insulation	Prevent condensation on the basement wall
4.1402.2c	Vapor permeability	When absorbent insulation materials are installed, assembly will remain vapor permeable to the interior in all climate zones except Zone 7	Provide drying potential to the basement

4.1402.3 Basement Wall Insulation—Ground Water Leakage

Topic: Basements and Crawl Spaces
Subtopic: Basements and Crawl Space Walls
4.1402.3 Detail Name: Basement Wall Insulation—Ground Water Leakage
Desired Outcome: Basement insulation improves thermal performance and ensures sufficient drying potential

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1402.3a	Drainage	A continuous drainage plane at the interior surface of the exterior basement wall will be created from the top of the wall to a drainage field at the bottom of the wall or sub-slab Drainage field will be run to daylight or pumped to the outside	Remove moisture on the surface of the exterior basement wall
4.1402.3b	Rough finish walls (e.g., rubble walls)	Drainage plane will be replaced with a waterproof membrane Only a non-absorbent insulation that complies with ASTM C665-06 will be applied Insulation will adhere to the waterproof membrane without voids Drainage field will be run to daylight or pumped to the outside	Create an air and moisture barrier on the interior side of the exterior basement wall and allow the insulation to conform to the irregularity of the surface Improve thermal performance of the basement and the living space
4.1402.3c	Thermal barrier, insulation	A non-absorbent insulation will be used with a minimum expected service life of 10 years A fire-rated material will be used if the insulation is left exposed	Improve thermal performance of the basement and the living space
4.1402.3d	Location	Insulation will be installed continuously from the top of the band joist to the top of the slab	Maintain a continuous thermal boundary on the interior side of the exterior basement wall
4.1402.3e	Termite protection	Where termite pressure exists, if sub-slab drainage is installed, termite treatment will be performed before re-installing the slab	Provide termite protection

4.1402.3f	Insulation attachment	Insulation will be attached with a durable connection equal to or better than the manufacturer specifications, whichever is more durable A minimum expected service life of 10 years will be ensured	Secure thermal boundary without compromising the insulation
4.1402.3g	R-value	Regional IECC will be followed for required R-value	Improve thermal performance of the basement and living space
4.1402.3h	Sealing	A continuous air barrier on the warm side of the thermal boundary will be installed, including floor-to-wall and wall-to-ceiling connections	Prevent convective air leakage from the basement, through the drainage plane, and back into the basement
4.1402.3i	Finish wall requirements	2012 IRC will be followed for finished wall details in basements	Install a durable, finished wall

4.1601.1 Insulating Flex Ducts

Topic: Ducts
Subtopic: Insulating Ducts
4.1601.1 Detail Name: Insulating Flex Ducts
Desired Outcome: Lower conductive heat transfer by ducts and decreased condensation on duct vapor barrier

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1601.1a	Removal of existing flexible ducting	All accessible low R-value flexible ducting will be removed from premises	Ensure installation of proper R-value ducts
4.1601.1b	Selection of new flexible ducting	All flexible ducting will have a minimum of R-8	Minimize thermal conductance of the duct system
4.1601.1c	Sizing of new flex	Duct sizing procedures will be conducted when replacing flex duct	Improve comfort in rooms Improve fan performance
4.1601.1d	Installation of flex	Flexible ducts will be supported in accordance with flex duct manufacturer's directions or local codes	Prevent sags, drops, or other bends that may interfere with correct air flow
4.1601.1e	Interior liner attachment	Interior liner of the flex-to-metal connection will be fastened with tie bands using a tie band tensioning tool or a mechanical band	Create a strong, secure attachment
4.1601.1f	Sealing of interior liner	Systems used to seal flexible air ducts and flexible air connectors will comply with UL 181B and will be marked "181 B-FX" for pressure-sensitive tape or "181 B-M" for mastic	Create an airtight connection
4.1601.1g	Attachment of exterior liner	Liner will be pulled up onto the metal duct as far as possible before securing The exterior liner of the flex duct will be fastened with tie bands using a tie band tensioning tool	Create a strong, durable attachment
4.1601.1h	Sealing of all accessible ducts	All accessible joints, seams, and connections in ductwork will be securely fastened and sealed with UL "181 B-M" compliant mastic (adhesives) or mastic-plus-embedded-fabric systems	Minimize duct leakage
4.1601.1i	Insulation of all fittings	All metal fittings including boots, elbows, and take-offs will be insulated separately using an R-11 duct wrap with vapor retarder	Minimize thermal conductance of the duct system
4.1601.1j	Completeness of vapor barrier	Vapor retarder of all duct insulation will be taped to the flex duct using tape that complies with UL 181B and will be marked "181 B-FX" for pressure-sensitive tape or "181 B-M" for mastic	Ensure a complete vapor barrier

4.1601.2 Insulating Metal Ducts

Topic: Ducts
Subtopic: Insulating Ducts
4.1601.2 Detail Name: Insulating Metal Ducts
Desired Outcome: Lowered thermal conductance of duct system and minimized condensation on the duct system

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
4.1601.2a	Selection of duct insulation material	Duct insulation on all ducts located in unconditioned spaces will be a minimum of R-8, in accordance with local code, or buried under attic insulation, whichever is greater, and have an attached vapor retarder Hot humid and warm coastal regions will not bury ducts	Decrease heat loss and condensation problems
4.1601.2b	Duct sealing	All joints, seams, and connections in ductwork shall be securely fastened and sealed with UL 181 B-M mastics (adhesives) or mastic-plus-embedded-fabric systems installed in accordance with the manufacturer's instructions before insulation is applied	Minimize duct leakage
4.1601.2c	Attachment of duct insulation	Duct insulation will be secured to the duct system using metal wire or rot-proof nylon twine Pattern of the wire or twine will be sufficient to securely hold the duct insulation tight to the duct	Ensure a secure connection between the duct system and the duct insulation
4.1601.2d	Taping of the duct insulation	Using a tape approved by the manufacturer, all seams and connection of the duct insulation will be taped No gaps will exist between pieces of duct insulation	Prevent gaps in the vapor barrier of the insulation

4.9901.1 General Information on Spray Polyurethane Foam (SPF)

Topic: Insulation—Additional Resources
Subtopic: Materials
4.9901.1 Detail Name: General information on Spray Polyurethane Foam
Desired Outcome: To provide general Information on spray polyurethane foam

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.

Once installed, there is essentially no difference in product performance between low- and high-pressure foams. It should be noted that the main differences between the delivery methods are in capital equipment investment, application rate, and PPE requirements.

Applicators should obtain training from the suppliers of SPF to help assure installation quality and use of all equipment as well as safe handling, use, and disposal of all chemicals used in the process. Spray Polyurethane Foam Alliance (SPFA) also offers additional training and accreditation for high-pressure SPF applicators.

Manufacturer Installation Instructions
In addition to the guidelines above, SPF applicators should follow all manufacturer installation instructions for the product being used. These instructions include product-specific documents such as application instructions, MSDSs, and evaluation reports.

Section 5: Heating and Cooling

5.3001.1 Load Calculation and Equipment Selection

Topic: Forced Air
Subtopic: Design
5.3001.1 Detail Name: Load Calculation and Equipment Selection
Desired Outcome: Equipment sized properly and operates efficiently

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
5.3001.1a	Load calculation	Load calculation will be performed in accordance with ANSI/ACCA 2 Manual J-2011 (Residential Load Calculation) and manufacturer specifications	Properly size equipment for load
5.3001.1b	Equipment selection	Equipment selection will be performed in accordance with ANSI/ACCA Manual S and manufacturer specifications	Ensure equipment is able to heat, cool, and dehumidify the house
5.3001.1c	Air filtration	New central forced air HVAC systems will have minimum MERV 6 filtration with no air bypass around the filters	Particle removal to protect equipment and help maintain indoor air quality

5.3001.2 Ductwork and Termination Design

Topic: Forced Air
Subtopic: Design
5.3001.2 Detail Name: Ductwork and Termination Design
Desired Outcome: Efficient air flow to all rooms ensured by proper ductwork

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
5.3001.2a	Duct design	Duct design will be performed in accordance with ANSI/ACCA Manual D and manufacturer specifications	Maximize air flow
5.3001.2b	Termination design	Termination design will be performed in accordance with ANSI/ACCA Manual T and manufacturer specifications	Maximize air flow Ensure occupant comfort
5.3001.2c	Air filtration	New central forced air HVAC systems will have minimum MERV 6 filtration with no air bypass around the filters	Particle removal to protect equipment and help maintain indoor air quality

5.3002.1 Preparation for New Equipment

Topic: Forced Air
Subtopic: Site Preparation
5.3002.1 Detail Name: Preparation for New Equipment
Desired Outcome: Existing equipment removed safely and lawfully

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

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
5.3002.1a	Access	A code compliant walkway and service platform will be installed in attics, if not present Walkway and platform will be above the level of insulation (if practical)	Ensure new equipment can be installed and serviced Maintain adequate insulation level
5.3002.1b	Utility disconnect	Electricity and fuel will be turned off prior to starting removal of old appliance	Protect workers and occupants from injury

5.3002.1c	Refrigerant recovery	Refrigerant will be recovered in accordance with 40 CFR 608 (EPA) by a licensed contractor	Comply with Safe Handling of Refrigerant Law Protect workers and occupants from injury
5.3002.1d	Equipment disconnection	Refrigerant lines, plumbing, ducts, electric, control wires, vents, and fuel supply will be disconnected	Ensure equipment can be removed
5.3002.1e	Removal	Equipment will be removed (e.g., furnace, air handler, evaporator, condensing unit) Equipment will be removed from space without damaging property and disturbing or compressing the insulation Equipment will be disposed of in accordance with local laws and regulations, recycling materials when feasible	Provide room to install new equipment and work safely Comply with applicable disposal laws

5.3003.1 Data Plate Verification

Topic: Forced Air
Subtopic: System Assessment and Maintenance
5.3003.1 Detail Name: Data Plate Verification
Desired Outcome: Data recorded for commissioning and future service work is recorded

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

5.3003.2 Combustion Analysis of Oil-Fired Appliances

Topic: Forced Air
Subtopic: System Assessment and Maintenance
5.3003.2 Detail Name: Combustion Analysis of Oil-Fired Appliances
Desired Outcome: Analysis on critical components and operations completed in accordance with industry and manufacturer specifications

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

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
5.3003.2a	Oil system: nozzle size	Nozzle size 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
5.3003.2b	Fuel 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

5.3003.2c	Oil system: steady state efficiency (SSE)	Measurement will be verified in accordance with manufacturer specifications	Ensure equipment operates as designed Ensure equipment operates safely Ensure equipment operates efficiently Ensure equipment is durable
5.3003.2d	Oil system: smoke test (This test must be conducted before any combustion testing is completed)	Smoke spot reading will be in accordance with burner manufacturer specifications If smoke test is more than actionable levels, specify a clean and tune	Ensure equipment operates as designed Ensure equipment operates safely Ensure equipment operates efficiently Ensure equipment is durable
5.3003.2e	Net stack temperature	Net stack temperature will be measured and verified in accordance with manufacturer specifications	Ensure equipment operates as designed Ensure equipment operates safely Ensure equipment operates efficiently Ensure equipment is durable
5.3003.2f	Carbon dioxide and oxygen	Measurement will be verified in accordance with industry manuals and manufacturer specifications	Ensure equipment operates as designed Ensure equipment operates safely Ensure equipment operates efficiently Ensure equipment is durable
5.3003.2g	Excess air	Excess air will be calculated and shown to be in accordance with manufacturer specifications	Ensure equipment operates as designed Ensure equipment operates safely Ensure equipment operates efficiently Ensure equipment is durable
5.3003.2h	CO in flue gas	Undiluted flue gases will be checked with a calibrated combustion analyzer For CO levels exceeding 200 ppm as measured, or 400 ppm air-free measurement, service will be provided to reduce CO to below these levels (unless CO measurement is within manufacturer specifications)	Ensure equipment operates as designed Ensure equipment operates safely Ensure equipment operates efficiently Ensure equipment is durable

5.3003.3 Evaluating Air Flow

Topic: Forced Air
Subtopic: System Assessment and Maintenance
5.3003.3 Detail Name: Evaluating Air Flow
Desired Outcome: Air flow is properly tested

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

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
5.3003.3a	Total air flow	Total system air flow will be measured by: • Temperature rise • Flow plate • Fan depressurization device (e.g., Duct Blaster, DucTester)	Ensure equipment operates as designed Ensure equipment operates efficiently Ensure equipment provides comfort Ensure equipment operates safely Ensure equipment is durable
5.3003.3b	External static pressure	External static pressure will be in accordance with manufacturer specifications	Ensure equipment operates as designed Ensure equipment operates efficiently Ensure equipment provides comfort Ensure equipment operates safely Ensure equipment is durable

5.3003.3c	Pressure	Pressure drop across cooling coils will be in accordance with manufacturer specifications	Ensure equipment operates as designed Ensure equipment operates efficiently Ensure equipment provides comfort Ensure equipment operates safely Ensure equipment is durable
5.3003.3d	Pressure drop: filter	Pressure drop across filter will be in accordance with manufacturer specifications	Ensure equipment operates as designed Ensure equipment operates efficiently Ensure equipment provides comfort Ensure equipment operates safely Ensure equipment is durable
5.3003.3e	Balancing room flow: new ductwork	Air flow will be measured at each register to ensure proper air flow delivery	Ensure equipment operates as designed Ensure equipment operates efficiently Ensure equipment provides comfort Ensure equipment operates safely Ensure equipment is durable
5.3003.3f	Supply wet bulb and dry bulb	Supply wet bulb and dry bulb air temperatures will be recorded	Ensure equipment operates as designed Ensure equipment operates efficiently Ensure equipment provides comfort Ensure equipment operates safely Ensure equipment is durable
5.3003.3g	Return wet bulb and dry bulb	Return wet bulb and dry bulb air temperatures will be recorded	Ensure equipment operates as designed Ensure equipment operates efficiently Ensure equipment provides comfort Ensure equipment operates safely Ensure equipment is durable
5.3003.3h	Temperature rise: gas and oil furnaces only	Temperature rise between the supply and return will be in accordance with manufacturer specifications	Ensure equipment operates as designed Ensure equipment operates efficiently Ensure equipment provides comfort Ensure equipment operates safely Ensure equipment is durable

5.3003.4 Evaluating Electrical Service

Topic: Forced Air
Subtopic: System Assessment and Maintenance
5.3003.4 Detail Name: Evaluating Electrical Service
Desired Outcome: Electrical components properly tested

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

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
5.3003.4a	Polarity	Polarity of equipment will be correct	Ensure equipment operates as designed Ensure equipment operates safely
5.3003.4b	Voltage/amperage: incoming power	Voltage/amperage will be in accordance with manufacturer specifications	Ensure equipment operates as designed
5.3003.4c	Voltage: contactor	In accordance with manufacturer specifications, voltage drop will be within acceptable range	Ensure contactor does not overheat Ensure equipment operates as designed
5.3003.4d	Grounding	Grounding must conform to meet NFPA 70 National Electric Code	Ensure equipment operates as designed Ensure equipment operates safely

5.3003.4e	Blower amperage	Amperage will not exceed manufacturer full load amperage	Ensure equipment operates as designed Ensure equipment operates efficiently Ensure equipment operates safely
5.3003.4f	Compressor amperage	Amperage will not exceed manufacturer full load amperage	Ensure equipment operates as designed Ensure equipment operates efficiently Ensure equipment operates safely
5.3003.4g	Door switch operation	Blower compartment safety switch operation will be verified	Ensure blower does not operate during service
5.3003.4h	Heat pump: emergency heat	Emergency heat circuit functions will be verified	Ensure system delivers heat in case of compressor failure

5.3003.5 Refrigerant Line Inspection

Topic: Forced Air
Subtopic: System Assessment and Maintenance
5.3003.5 Detail Name: Refrigerant Line Inspection
Desired Outcome: Refrigerant lines properly installed

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

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
5.3003.5a	Insulation	All liquid refrigerant lines will be insulated to a minimum of R-4 Vapor or high side lines will not be insulated unless specified by the equipment's manufacturer Suction lines will be insulated to a minimum of R-4	Ensure refrigerant lines do not gain excessive heat
5.3003.5b	Ultraviolet (UV) protection of insulation	If exposed to sunlight, refrigerant line insulation will be protected from UV degradation in accordance with manufacturer specifications, 2012 IRC N1103.3.1, or local code	Install insulation so it does not degrade
5.3003.5c	Sizing	Refrigerant lines will be sized to meet manufacturer specifications for the installed equipment	Ensure system moves appropriate volume of refrigerant
5.3003.5d	Installation quality	Refrigerant lines will be installed without kinks, crimps, or excessive bends	Ensure system moves appropriate volume of refrigerant
5.3003.5e	Support	Refrigerant lines will be routed, supported, and secured to house in a manner that protects the line from damage by workers or occupants	Ensure refrigerant lines do not move, vibrate, or sag Protect lines from damage

5.3003.6 Evaluating Sequence of Operation

Topic: Forced Air
Subtopic: System Assessment and Maintenance
5.3003.6 Detail Name: Evaluating Sequence of Operation
Desired Outcome: Sequence of operation of the system verified

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
5.3003.6a	Verification	The sequence of operation of the system will be verified in accordance with the manufacturer installation, operation, and maintenance manual	Ensure system components function and operate in the correct sequence

5.3003.7 Occupant Education

Topic: Forced Air
Subtopic: System Assessment and Maintenance
5.3003.7 Detail Name: Occupant Education
Desired Outcome: Occupants understand their role and responsibility in the safe, effective, and efficient operation of the equipment

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
5.3003.7a	Basic operation	Basic operation of the equipment will be explained to the occupant (e.g., design conditions, efficiency measures, differences from previous system or situation)	Ensure occupant has a reasonable expectation of the equipment's capability
5.3003.7b	System controls (e.g., thermostat, humidistat)	Proper operation and programming of system controls to achieve temperature and humidity control will be explained to the occupant	Ensure occupant can operate system controls
5.3003.7c	System disconnects	Indoor and outdoor electrical disconnects and fuel shut-offs will be demonstrated to occupant	Ensure occupant can shut off equipment in emergencies
5.3003.7d	Combustion air inlets	Location of combustion air inlets will be identified for occupant in accordance with NFPA 31, 54, and 58 Importance of not blocking inlets will be explained to occupant	Ensure occupant does not block combustion air inlets
5.3003.7e	Blocking air flow	Importance of cleaning dust and debris from return grilles will be explained to occupant Proper placement of interior furnishings with respect to registers will be explained to occupant Negative consequences of closing registers will be explained to occupant Importance of leaving interior doors open as much as possible will be explained to occupant	Ensure occupant does not prevent equipment from operating as designed
5.3003.7f	Routine maintenance	Proper filter selection and how to change the filter will be explained to occupant Importance of keeping outside unit clear of debris, vegetation, decks, and other blockage will be explained to occupant Importance and timing of routine professional maintenance will be explained to occupant	Ensure equipment operates as designed
5.3003.7g	Calling heating, ventilation, and air conditioning (HVAC) contractor	Situations when the occupant should contact the HVAC contractor will be explained, including: • Fuel odors • Water draining from secondary drainline • Emergency heat indicator always on for a heat pump system • System blowing cold air during heating season and vice versa • Icing of the evaporator coil during cooling mode • Outside unit never defrosts • Unusual noises • Unusual odors	Notify occupant to contact installer when system is not operating as designed
5.3003.7h	Carbon monoxide (CO)	A carbon monoxide (CO) alarm will be installed	Occupant will be made aware of operation of CO alarm
5.3003.7i	Warranty and service	Occupant will be provided with relevant manuals and warranties The labor warranty will be explained and the occupant will be given a phone number to call for warranty service	Provide manuals and warranties for future servicing

5.3003.8 Evaporative Cooler Maintenance

Topic: Forced Air
Subtopic: System Assessment and Maintenance
5.3003.8 Detail Name: Evaporative Cooler Maintenance
Desired Outcome: Evaporative cooler evaluated and maintained as needed

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
5.3003.8a	Assessment and diagnosis	The following system elements will be assessed: • Pump • Pan • Spider • Float • Damper • Roof jack support • Water line • Water valve • Electrical • Pads • Motor • Fan Elements will be repaired or replaced as needed in accordance with manufacturer instructions	Ensure all components function properly
5.3003.8b	Repair and maintenance	Calcium deposits will be removed Pads will be replaced Any additional repairs or replacements will be made as necessary in accordance with manufacturer's instructions	Protect the potable water supply from cross-contamination Ensure evaporative cooler functions properly
5.3003.8c	Occupant education	A regular service schedule will be recommended to occupant Issues regarding multiple systems running will be discussed with occupant	Ensure the occupant understands basic operation and the importance of regular maintenance

5.3003.9 Heating and Cooling Controls

Topic: Forced Air
Subtopic: System Assessment and Maintenance
5.3003.9 Detail Name: Heating and Cooling Controls
Desired Outcome: Heating and cooling controls installed and set properly

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
5.3003.9a	Removal of mercury-based thermostats	Mercury based thermostat will be removed safely and disposed of in accordance with EPA regulations	Protect workers and occupants from injury Protect environment from damage
5.3003.9b	Removal of existing controls	Existing controls will be removed in accordance with EPA lead-safe work rules	Protect workers and occupants from injury Protect environment from damage
5.3003.9c	Penetrations	Penetrations for control wiring will be sealed with a durable sealant (e.g., caulk, silicone, foam)	Ensure controls operate as designed Minimize infiltration and exfiltration from house
5.3003.9d	Thermostat location	Thermostats will be installed to reflect the temperature of the zone in which they are installed Thermostats will not be exposed to extreme temperatures, radiant heat sources, and drafts	Ensure controls operate as designed

5.3003.9e	Blower speed	Blower speed will be set for equipment in accordance with manufacturer specifications	Ensure equipment has correct air flow
5.3003.9f	Thermostat selection: heat pump	A thermostat with equipment supplementary heat lockout that can interface with an outside temperature sensor will be selected	Ensure supplementary heater operation is prevented when the heat pump is capable of meeting the load
5.3003.9g	Heat pump: supplementary heat	Supplementary heat will be used on air-to-air heat pumps with conditions that allow for a balance point of less than 30°F Supplementary heat lockout will be installed and set to manufacturer specifications	Ensure supplementary heater operation is prevented when the heat pump is capable of meeting the load
5.3003.9h	Heat pump: low ambient compressor lockout	For air-to-air heat pumps, low ambient compressor lockout will be set to 0°F outdoor temperature or to manufacturer specifications	Ensure supplementary heater operation is prevented when the heat pump is capable of meeting the load
5.3003.9i	Heat pump: outside temperature sensor	An outdoor temperature sensor will be installed in accordance with manufacturer specifications	Ensure equipment operates as designed
5.3003.9j	Heat pump: supplementary heat wiring	Supplementary heat will be wired onto second-stage heating terminal in accordance with manufacturer specifications	Do not operate supplementary heat in stage one heating
5.3003.9k	Thermostat: installer programming	The installer options will be set to match the thermostat to the equipment and control board settings	Ensure equipment operates as designed
5.3003.9l	Time delay settings	Time delay for equipment will be set in accordance with manufacturer specifications and as appropriate for the climate zone (e.g., no time delay for hot humid climates)	Maximize transfer of heat without adversely affecting indoor humidity levels
5.3003.9m	Humidistat: location	Humidistat will be installed to reflect humidity of the zone in which it is installed Humidistat will be installed in a dry location	Ensure controls operate as designed
5.3003.9n	Occupant education	Occupants will be educated on proper use of thermostat including: • Proper use of setbacks for air conditioners and heat pumps • Allowing occupant comfort to determine setback for combustion heating appliances • Using emergency heat appropriately	Ensure equipment and controls operate as designed Provide comfort throughout house

5.3003.10 Condensate Drainage of Heating and Air Conditioning Equipment

Topic: Forced Air
Subtopic: System Assessment and Maintenance
5.3003.10 Detail Name: Condensate Drainage of Heating and Air Conditioning Equipment
Desired Outcome: Equipment and condensate drain operate as designed

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

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
5.3003.10a	Connection	Connections in condensate drain system will be watertight	Ensure condensate drain connections do not leak
5.3003.10b	Insulation	Condensate drainlines will be insulated with a minimum 1″ of insulation with a vapor retarder when there is potential for condensation or freezing on the drainline	Ensure condensate drain connections do not leak
5.3003.10c	Overflow protection: upflow	Secondary drain pan and float switch will be installed when overflow could damage finished surfaces OR Float switch in the primary condensate drain for upflow systems will be installed when overflow could damage finished surfaces	Ensure condensate drain connections do not leak
5.3003.10d	Pumps	Condensate drain pumps will be installed when condensate cannot be drained by gravity Power source for pump will be installed Operation and drainage of pump will be verified	Ensure condensate drain connections do not leak

5.3003.10e	Vents and traps	Vents and traps will be installed on condensate drainlines Trap supplied with the equipment will be used and manufacturer specifications will be followed	Ensure condensate drain operates as designed Ensure condensate drain does not leak air
5.3003.10f	Drain pan	Condensate from all cooling coils or evaporators shall be conveyed from the drain pan outlet to an approved place of disposal Such piping shall maintain a minimum horizontal slope in the direction of discharge of not less than 1/8 unit vertical in 12 units horizontal (1% slope) Condensate shall not discharge into a street, alley, or other areas where it would cause a nuisance	Prevent water damage from drain system malfunction
5.3003.10g	Float switch	All secondary drain pans will have a float switch and be drained away through a drainline	Prevent water overflowing the pan and draining onto the ceiling below
5.3003.10h	Termination	Condensate drain will be terminated in accordance with local codes	Ensure condensate does not leak to the house Ensure condensate drain does not freeze

5.3101.1 Heat Load Calculation—Whole House

Topic: Hydronic Heating
Subtopic: Design
5.3101.1 Detail Name: Heat Load Calculation—Whole House
Desired Outcome: A properly sized heating appliance selected

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
5.3101.1a	Heating load calculation	Load calculation will be performed in accordance with ANSI/ACCA 2 Manual J-2011 (Residential Load Calculation) and manufacturer specifications	Enable proper sizing of the heating appliance
5.3101.1b	Equipment selection	Equipment selection will be performed in accordance with ANSI/ACCA Manual S and manufacturer specifications	Ensure equipment is able to heat the house

5.3101.2 Space Load Calculation—Heat Emitter Sizing

Topic: Hydronic Heating
Subtopic: Design
5.3101.2 Detail Name: Space Load Calculation—Heat Emitter Sizing
Desired Outcome: Heat emitter selected provides adequate heat output

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
5.3101.2a	Space load calculation	Load calculation will be performed in accordance with ANSI/ACCA 2 Manual J-2011 (Residential Load Calculation) and manufacturer specifications	Enable proper sizing of the heating appliance

5.3104.1 Controls—Thermostat Replacement

Topic: Hydronic Heating
Subtopic: System Assessment and Maintenance
5.3104.1 Detail Name: Controls—Thermostat Replacement
Desired Outcome: Thermostat replaced when appropriate

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
5.3104.1a	Visual inspection	Thermostats will be visually located Verify anticipator setting, if appropriate for thermostat model Replacement will be recommended if a digital, double setback thermostat is not present	Determine if existing thermostats need to be replaced
5.3104.1b	Mercury assessment	Thermostats containing mercury will be identified and disposed of in accordance with EPA guidance	Protect workers and occupants from mercury exposure
5.3104.1c	Removal (if removal is recommended)	Heating system will be de-energized before removal Thermostat will be removed Compatibility will be verified (e.g., voltage, wiring condition, location) and documented Location of existing thermostat will be assessed for appropriateness (e.g., central to the house, out of direct sunlight, away from supply air, protected from abnormal radiant surface temperatures)	Proper removal of thermostat
5.3104.1d	Installation	Location for new thermostat will be determined Compatibility with new thermostat will be verified (e.g., voltage, wiring, condition, location) Replacement will be recommended if a digital, double setback thermostat is not present Heating system will be re-energized and cycled Thermostat will be programmed to occupant lifestyle choices	Achieve comfort and energy savings for the occupant
5.3104.1e	Disposal	Thermostats will be disposed of in accordance with EPA guidelines and local regulations	Prevent mercury from entering the environment
5.3104.1f	Occupant education	Occupant will be involved in the initial programming of thermostat and educated on common settings and programming On new installs, occupants will be encouraged to save the manual and keep it accessible	Educate occupant on best use

5.3104.2 Maintenance: Gas Boiler Service Inspection

Topic: Hydronic Heating
Subtopic: System Assessment and Maintenance
5.3104.2 Detail Name: Maintenance: Gas Boiler Service Inspection
Desired Outcome: Boiler service improves safety, efficiency, and performance

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

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
5.3104.2a	Visual inspection	The following conditions will be assessed by a licensed contractor: • Water, steam, and fuel leaks • Damaged or missing pipe insulation • Venting issues—draft and condensation (e.g., soot, rusting of flue pipe, burned paint or wires, efflorescence) • Corrosion (e.g., rust, mineral deposits) • General condition of components	Observe general conditions to determine needed repairs or maintenance
5.3104.2b	Appliance gas valve	When replacement is necessary, gas valve will be removed and replaced according to manufacturer specifications	Provide gas to burner when there is a call for heat Control volume of gas for burner Ensure the safe shut off of gas at the end of a call for heat
5.3104.2c	Ignition system	Components of ignition system will be repaired or replaced in accordance with manufacturer specifications	Do not allow flow of main burner gas without proof of ignition
5.3104.2d	Main gas burners	Problems that may interfere with flame (e.g., dust, debris, misalignment) will be cleaned, vacuumed, and adjusted	Produce combustion in a safe, clean, and efficient manner
5.3104.2e	Venting	Flue gases will be removed from the venting system in accordance with 2012 IRC G2427 or per manufacturer specifications	Ensure the safety and durability of the venting system
5.3104.2f	Flue gas testing	Undiluted flue gases will be checked with a calibrated combustion analyzer in accordance with BPI-1100-T-2012 If combustion is not in compliance with BPI-1100-T-2012, diagnostics and adjustments will be done to meet manufacturer specifications or local codes	Confirm that combustion occurs safely with maximum efficiency
5.3104.2g	Combustion efficiency checks	Undiluted flue gases will be checked with a calibrated combustion analyzer in accordance with accepted protocol to determine if acceptable boiler efficiency is being maintained If boilers are found to be out of compliance, a combustion analysis will be administered and minimum stack temperature will be in accordance with manufacturer specifications	Increase the operational efficiency of the system Improve occupant comfort
5.3104.2h	Occupant health	All homes will have a carbon monoxide (CO) alarm	Ensure ambient CO does not exceed acceptable levels after completion of work
5.3104.2i	Occupant education	Occupants will be educated on the operation and maintenance of the carbon monoxide (CO) alarm Completed work and recommended maintenance will be reviewed	Ensure occupant is informed of the safe and efficient operation and maintenance of the work performed

5.3104.3 Maintenance: Checklist

Topic: Hydronic Heating
Subtopic: System Assessment and Maintenance
5.3104.3 Detail Name: Maintenance: Checklist
Desired Outcome: Thorough maintenance improves safety, efficiency, and performance

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

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
5.3104.3a	Health and safety	Combustion safety testing will be performed in accordance with the Health and Safety Chapter of the (Standard Work Specifications for Single Family Housing) or other equivalent practice	Identify potential health and safety issues
5.3104.3b	Visual inspection	The following conditions will be inspected: • Water, steam, and fuel leaks • Damaged or missing pipe insulation • Venting issues – draft and condensation (e.g., soot, rusting of flue pipe, burned paint or wires, efflorescence) • Corrosion (e.g., rust, mineral deposits) • General condition of components	Observe general conditions to determine needed repairs or maintenance
5.3104.3c	Pipe insulation inspection	Pipe insulation will be inspected, including: • Integrity—complete coverage, no holes or tears • Damage—holes or tears • Complete coverage—insulation missing If asbestos is suspected, occupants will be notified and asbestos will not be disturbed Required repair or replacement will be performed in accordance with the following conditions: • Materials will be approved for steam heating pipes • Materials will be approved for hot water heating pipes • Insulation will completely cover pipe Pipe insulation will be installed in accordance with manufacturer specifications	Minimize heat loss Improve performance of the system
5.3104.3d	Check system pressure	Check system pressure will be verified Check system pressure will be 1 pound per square inch gauge (psig) per 28" of system height	Keep system operating within pressure parameters
5.3104.3e	Purge system	Devices that are under performing or have need of purging will be purged as needed	Remove air from the system to maximize performance
5.3104.3f	Automatic fill	Automatic fill valve will be inspected to ensure it maintains system pressure If pressure is not maintained, replacement will be made in accordance with the following criteria: • Valve will be replaced and include backflow prevention; existing backflow protection shall be tested to verify operation • Components will be installed in accordance with manufacturer specifications • Correct system pressure will be verified	Maintain optimal system pressure to maximize performance
5.3104.3g	Gauge glass	Gauge glass will be inspected for erosion, cracks, or drying Damaged gauge glass on boiler will be replaced in accordance with manufacturer specifications Gauge glass that is coated with dirt or sediment, making it difficult to observe the water level of the boiler, will be removed, cleaned, and replaced	Ensure gauge glass is in safe operating condition to allow observation of water level in boiler

5.3104.3h	Low water cut-off: float type	Operation of low-water cutoff on steam boilers 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 Operation of low-water cutoff on hot water boilers is applicable only if proper test setup is available on-site, to avoid draining the system Occupants will be educated on the correct method to drain the low water cutoff weekly (must drain once per week to remove sediment from float chamber of low-water cutoff)	Ensure safe minimum water level of the boiler Maintain safe operation of the low water cut-off on ongoing basis
5.3104.3i	Low water cut-off: immersion	An immersion low-water cutoff will be installed and operable	Ensure safe minimum water level of the boiler
5.3104.3j	Expansion tank: non-bladder and bladder	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 Expansion tanks will be properly supported with strapping Tanks that are full of water will be drained; after expansion tank is drained, re-establish the correct water level in relation to system pressure Expansion tanks with bladders will have air charged to the manufacturer pressure specifications 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	Absorb water expansion of the system
5.3104.3k	Flush or skim steam boiler	Manufacturer specifications for flushing or skimming steam boiler will be followed	Ensure boiler produces dry steam
5.3104.3l	System temperature or pressure gauge	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	Allow for accurate observation of system temperature and pressure
5.3104.3m	Circulators	Non-working motors that cannot be serviced will be replaced with a new motor New motors will be installed in accordance with manufacturer specifications Oil-lubricated circulators will be installed in proper alignment with the pump coupler and will be supported so they do not sag Bearings will have free movement without binding Shaft seals will not leak Bearings in inoperable, water-lubricated circulators will be freed, if possible, before replacement with a new circulation pump	Ensure circulation of water at designated velocity in system without leaks in the circulators
5.3104.3n	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
5.3104.3o	Condensate	If boiler is 90% efficient or more, condensate discharge will be an acceptable pH level, in accordance with local code, and will be drained to the exterior of the house, away from the foundation Condensate pumps will be installed, if needed, to ensure proper drainage	Bring the condensate to an acceptable pH and discharge to appropriate location
5.3104.3p	Temperature, pressure valves, and air vents	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

5.3104.3q	Maintenance records	Keeping records of all maintenance will be recommended to occupants Copies or access to installation and operation manuals will be provided	Provide a history of system installation and maintenance to improve future maintenance or repair
5.3104.3r	Occupant health and safety	All homes will have a carbon monoxide (CO) alarm	Ensure occupant health and safety
5.3104.3s	Occupant education	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

5.3201.1 Indigenous Shading

Topic: Shading
Subtopic: Landscaping
5.3201.1 Detail Name: Indigenous Shading
Desired Outcome: Heat gain reduced through use of indigenous shade plants

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
5.3201.1a	Plant selection	All plantings intended for shading will be indigenous and drought resistant	Ensure plantings survive in local conditions using a minimum amount of water
5.3201.1b	Size	No planting will be chosen that will grow to a height that would cause damage to the house if it or any part of it fell on the house	Reduce possibility of damage to the house

Section 6: Ventilation

6.6002.1 Ducts

Topic: Exhaust
Subtopic: Components
6.6002.1 Detail Name: Ducts
Desired Outcome: Installed ducts effectively move the required volume of air and prevent condensation

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
6.6002.1a	Duct design and configuration	Ventilation ducts will be as short, straight, and smooth as possible Ventilation ducts will not be smaller than the connections to which they are attached	Effectively move the required volume of air
6.6002.1b	Duct insulation	Ducts installed outside of the thermal envelope will be insulated to a minimum of R-8 or equivalent to local codes	Prevent condensation from forming or collecting inside of the ductwork
6.6002.1c	Duct support	Flexible and duct board ducts and plenums will be supported every 4' using a minimum of 1 ½" wide material Support materials will be applied in a way that does not crimp ductwork or cause the interior dimensions of the ductwork to be less than specified (e.g., ceiling, framing, strapping); duct support must be installed in accordance with authority having jurisdiction Metal ducts will be supported by 1/2" or wider 18-gauge strapping or 12 gauge or thicker galvanized wire no less than 10' apart	Effectively move the required volume of air Preserve the integrity of the duct system Eliminate falling and sagging
6.6002.1d	Duct connections	Round metal-to-metal or metal-to-PVC will be fastened with a minimum of three equally spaced screws Other metal-to-metal or metal-to-PVC connections will be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems, or tapes Flexible duct-to-metal or flexible duct-to-PVC will be fastened with tie bands using a tie band tensioning tool PVC-to-PVC materials will be fastened with approved PVC cement Other specialized duct fittings will be fastened in accordance with manufacturer specifications In addition to mechanical fasteners, duct connections will be sealed with UL 181B or 181B-M listed material	Effectively move the required volume of air Preserve the integrity of the duct system
6.6002.1e	Duct materials	Flexible materials will be UL 181 listed or Air Diffusion Council approved Rigid, kitchen fans gauges shall meet code requirements or authority having jurisdiction	Effectively move the required volume of air Preserve the integrity of the duct system

6.6002.2 Terminations

Topic: Exhaust
Subtopic: Components
6.6002.2 Detail Name: Terminations
Desired Outcome: Securely installed termination fittings with unrestricted air flow

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
6.6002.2a	Hole in building shell	A hole no greater than a 1/4" greater than the fitting will be cut to accommodate termination fitting	Allow for ease of weatherproofing
6.6002.2b	Termination fitting	A termination fitting with an integrated collar will be used Collar will be at least the same diameter as the exhaust fan outlet; if collar is larger than exhaust fan outlet, a rigid metal transition will be used Fitting will be appropriate for regional weather conditions and installation location on house so as not to be rendered inoperable	Effectively move the required volume of air to the outside Preserve integrity of the building envelope Ensure durable installation
6.6002.2c	Duct to termination connection	Duct will be connected and sealed to termination fitting as follows: • Round metal-to-metal or metal-to-PVC will be fastened with a minimum of three equally spaced screws • Other metal-to-metal or metal-to-PVC connections will be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems, or tapes • Flexible duct-to-metal or flexible duct-to-PVC will be fastened with tie bands using a tie band tensioning tool • PVC-to-PVC materials will be fastened with approved PVC cement • Other specialized duct fittings will be fastened in accordance with manufacturer specifications • In addition to mechanical fasteners, duct connections will be sealed with UL 181B or 181B-M listed material Fasteners will not inhibit damper operation	Effectively move the required volume of air to the outside Preserve integrity of the building envelope Ensure durable installation
6.6002.2d	Weatherproof installation	Exterior termination fitting will be flashed or weather sealed Water will be directed away from penetration Installation will not inhibit damper operation Manufacturer specifications will be followed	Preserve integrity of the building envelope Ensure a weather tight and durable termination installation Ensure unrestricted air flow
6.6002.2e	Pest exclusion	Screen material with no less than ¼" and no greater than ½" hole size in any direction will be used Installation will not inhibit damper operation or restrict air flow	Prevent pest entry Ensure proper air flow
6.6002.2f	Termination location	Terminations will be installed: • A minimum of 3' away from any property line • A minimum of 3' away from operable opening to houses • A minimum of 10' away from mechanical intake • As required by authority having jurisdiction	Prevent exhaust from reentering house
6.6002.2g	Kitchen exhaust	Galvanized steel, stainless steel, or copper will be used for termination fitting for kitchen exhaust	Prevent a fire hazard

6.6002.3 Exhaust-Only Ventilation—Fan Intake Grille Location

Topic: Exhaust
Subtopic: Components
6.6002.3 Detail Name: Exhaust-Only Ventilation—Fan Intake Grille Location
Desired Outcome: Exhaust grille location optimizes either primary or local ventilation

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

6.6003.1 Surface-Mounted Ducted

Topic: Exhaust
Subtopic: Fans
6.6003.1 Detail Name: Surface-Mounted Ducted
Desired Outcome: Surface-mounted ducted fans installed to specification

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

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
6.6003.1a	Hole through interior surface	A hole no greater than a 1/4" greater than the assembly will be cut to accommodate fan assembly	Minimize repair work Ensure a secure installation
6.6003.1b	Wiring	Wiring will be installed in accordance with original equipment manufacturer specifications, and local and national electrical and mechanical codes	Prevent an electrical hazard
6.6003.1c	Fan mounting	Fan outlet will be oriented toward the final termination location Fan will be oriented so the equivalent length of the duct run is as short as possible Fan will be mounted securely in accordance with manufacturer specifications	Ensure short duct run to achieve optimum air flow Ensure a secure installation Ensure fan housing does not shake, rattle, or hum when operating
6.6003.1d	Backdraft damper	A backdraft damper will be installed between the outlet side of the fan and the exterior	Prevent reverse air flow when the fan is off
6.6003.1e	Duct to fan connection	Duct-to-fan outlet will be connected and sealed as follows: • Round metal-to-metal or metal-to-PVC will be fastened with a minimum of three equally spaced screws • Other metal-to-metal or metal-to-PVC connections will be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems, or tapes • Flexible duct-to-metal or flexible duct-to-PVC will be fastened with tie bands using a tie band tensioning tool • PVC-to-PVC materials will be fastened with approved PVC cement • Other specialized duct fittings will be fastened according to manufacturer specifications • In addition to mechanical fasteners, duct connections will be sealed with UL 181B or 181B-M listed material	Exhaust to outside
6.6003.1f	Fan housing seal	Gaps and holes in fan housing will be sealed with caulk or other sealants in accordance with manufacturer recommendations Sealants will be compatible with their intended surfaces Sealants will be continuous and meet fire barrier specifications	Prevent air leakage through fan housing Ensure a permanent seal Prevent a fire hazard

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

6.6003.2 Inline

Topic: Exhaust
Subtopic: Fans
6.6003.2 Detail Name: Inline
Desired Outcome: Inline fans installed to specification

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

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
6.6003.2a	Wiring	Wiring will be installed in accordance with original equipment manufacturer specifications and local and national electrical and mechanical codes	Prevent an electrical hazard
6.6003.2b	Access	Fan and service switch will be accessible for maintenance according to NFPA 70 National Electric Code or local authority having jurisdiction	Fan and service switch will be accessible for maintenance
6.6003.2c	Fan mounting	Fan outlet will be oriented toward the final termination location Fan will be oriented so the equivalent length of the duct run is as short as possible Fan will be mounted securely in accordance with manufacturer specifications Fan will be isolated from the building framing unless specifically designed to be directly attached Fan will be installed remotely by installing ducting from intake grille	Ensure short duct run to achieve optimum air flow Ensure fan is installed securely Ensure fan housing or building framing does not shake, rattle, or hum when operating Minimize noise
6.6003.2d	Backdraft damper	A backdraft damper will be installed between the outlet side of the fan and the exterior	Prevent reverse air flow when the fan is off
6.6003.2e	Duct connections	Ducts will be connected and sealed to the intake fan and termination fitting as follows: • Round metal-to-metal or metal-to-PVC will be fastened with a minimum of three equally spaced screws • Other metal-to-metal or metal-to-PVC connections will be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems, or tapes • Flexible duct-to-metal or flexible duct-to-PVC will be fastened with tie bands using a tie band tensioning tool • PVC-to-PVC materials will be fastened with approved PVC cement • Other specialized duct fittings will be fastened in accordance with manufacturer specifications • In addition to mechanical fasteners, duct connections will be sealed with UL 181B or 181B-M listed material	Exhaust from desired location to outside Preserve integrity of the duct system and building envelope
6.6003.2f	Boot to interior surface seal	Sealants will be compatible with their intended surfaces Sealants will be continuous and meet fire barrier specifications	Prevent air leakage around intake housing Prevent a fire hazard
6.6003.2g	Air flow	Air flows in CFM will be measured and adjusted to meet the design requirements	Exhaust sufficient air from desired locations to outside

6.6003.2h	Preventing air leakage caused by exhaust fans	Leakage to the house from other spaces will be prevented (e.g., garages, unconditioned crawl spaces, unconditioned attics)	Ensure occupant health and safety
6.6003.2i	Combustion safety	Pressure effects caused by fans will be assessed and corrected when found outside of combustion safety standards Exhaust fans and other exhausting systems shall be provided with makeup air or other pressure relief	Ensure safe operation of combustion appliances

6.6003.3 Through the Wall

Topic: Exhaust
Subtopic: Fans
6.6003.3 Detail Name: Through the Wall
Desired Outcome: Through the wall fans installed to specification

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

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
6.6003.3a	Hole in building shell	A hole no greater than a 1/4 inch greater than the assembly will be cut to accommodate fan assembly	Allow for ease of weatherproofing
6.6003.3b	Wiring	Wiring will be installed in accordance with original equipment manufacturer specifications, and local and national electrical and mechanical codes	Prevent an electrical hazard
6.6003.3c	Fan mounting	Fan outlet will be oriented toward the final termination location Fan will be oriented so the equivalent length of the duct run is as short as possible Fan will be mounted securely according to manufacturer specifications	Install mounting fan securely Ensure fan housing does not shake, rattle, or hum when operating
6.6003.3d	Weatherproof installation	Exterior termination fitting will be flashed or weather sealed Water will be directed away from penetration Termination fitting installation will not inhibit damper operation Manufacturer specifications will be followed	Preserve integrity of the building envelope Ensure a weather tight and durable installation Ensure unrestricted air flow
6.6003.3e	Backdraft damper	A backdraft damper will be installed between the outlet side of the fan and the exterior	Prevent reverse air flow when the fan is off
6.6003.3f	Fan housing seal	Sealants will be compatible with their intended surfaces Sealants will be continuous and meet fire barrier specifications	Prevent air leakage through fan housing Ensure a permanent seal to the building air barrier
6.6003.3g	Fan to interior surface seal	Sealants will be compatible with their intended surfaces Sealants will be continuous and meet fire barrier specifications	Prevent air leakage around intake housing Prevent a fire hazard
6.6003.3h	Insulation	All components outside of the thermal envelope will be insulated to a minimum of R-8 or equivalent to local code Exception: If system operates continuously, fan housing need not be insulated	Preserve integrity of the duct system
6.6003.3i	Air flow	Air flows in CFM will be measured and adjusted to meet the design requirements	Exhaust sufficient air from desired locations to outside
6.6003.3j	Preventing air leakage caused by exhaust fans	Leakage to the house from other spaces will be prevented (e.g., garages, unconditioned crawl spaces, unconditioned attics)	Ensure occupant health and safety
6.6003.3k	Combustion safety	Pressure effects caused by fans will be assessed and corrected when found outside of combustion safety standards Exhaust fans and other exhausting systems shall be provided with makeup air or other pressure relief	Ensure safe operation of combustion appliances

6.6003.4 Multi-Port System

Topic: Exhaust
Subtopic: Fans
6.6003.4 Detail Name: Multi-Port System
Desired Outcome: Multi-port fans installed to specification

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

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
6.6003.4a	Wiring	Wiring will be installed in accordance with original equipment manufacturer specifications, and local and national electrical and mechanical codes	Prevent an electrical hazard
6.6003.4b	Access	Fan and access switch shall be accessible for maintenance according to NFPA 70 National Electric Code or local authority having jurisdiction	Achieve designed exhaust flow from desired locations to the outside
6.6003.4c	Fan mounting	Fan outlet will be oriented toward the final termination location Fan will be oriented so the equivalent length of the duct run is as short as possible Fan will be mounted securely in accordance with manufacturer specifications Fan will be isolated from the building framing unless specifically designed to be directly attached Fan will be installed remotely by ducting from intake grilles	Ensure short duct runs to achieve optimum air flows Ensure mounting is installed securely Ensure fan housing or building framing does not shake, rattle, or hum when operating Minimize noise
6.6003.4d	Backdraft dampers (required in intermittent systems)	A backdraft damper will be installed between the fan and the exterior unless the system operates continuously A backdraft damper will be installed in any duct serving any room with a separate exhaust (e.g., dryer)	Prevent reverse air flow when the system is off Prevent spread of contaminants between rooms
6.6003.4e	Combining intake ducts	All individual exhaust intake ducts will be combined on the upstream side of fan (e.g., Y-fitting, T-fitting, collector box) with the exception of dryer, kitchen, and garage	Exhaust air from desired locations to outside
6.6003.4f	Duct connections	Ducts will be connected and sealed to applicable intakes, collector box, fan, and termination fitting Ducts will be connected and sealed as follows: • Round metal-to-metal or metal-to-PVC will be fastened with a minimum of three equally spaced screws • Other metal-to-metal or metal-to-PVC connections will be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems, or tapes • Flexible duct-to-metal or flexible duct-to-PVC will be fastened with tie bands using a tie band tensioning tool • PVC-to-PVC materials will be fastened with approved PVC cement • Other specialized duct fittings will be fastened in accordance to manufacturer specifications • In addition to mechanical fasteners, duct connections will be sealed with UL 181B or 181B-M listed material	Exhaust air from desired locations to outside Preserve integrity of the duct system and building envelope
6.6003.4g	Insulation	All components outside of the thermal envelope will be insulated to a minimum of R-8 or equivalent to local code Exception: If system operates continuously, fan housing need not be insulated	Preserve integrity of the duct system
6.6003.4h	Boot to interior surface seal	Sealants will be compatible with their intended surfaces Sealants will be continuous and meet fire barrier specifications	Prevent air leakage around boot Ensure a permanent seal to the building air barrier Prevent a fire hazard

6.6003.4i	Air flow	Air flows in CFM will be measured and adjusted to meet the design requirements	Exhaust sufficient air from desired locations to outside
6.6003.4j	Preventing air leakage caused by exhaust fans	Air leakage into the house from other spaces will be prevented (e.g., garages, unconditioned crawl spaces, unconditioned attics)	Ensure occupant health and safety
6.6003.4k	Combustion safety	Pressure effects caused by fans will be assessed and corrected when found outside of combustion safety standards	Ensure safe operation of combustion appliances

6.6003.5 Garage Exhaust Fan

Topic: Exhaust
Subtopic: Fans
6.6003.5 Detail Name: Garage Exhaust Fan
Desired Outcome: Contaminants properly removed from house

For supporting reference material, see Appendix C.

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

6.6005.1 Clothes Dryer

Topic: Exhaust
Subtopic: Appliance Exhaust Vents
6.6005.1 Detail Name: Clothes Dryer
Desired Outcome: Dryer air exhausted efficiently and safely

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
6.6005.1a	Clothes dryer ducting	Clothes dryers will be ducted to the outdoors, which does not include unconditioned spaces such as attics and crawl spaces that are ventilated with the outdoors As short a run as practical of rigid sheet metal or semi-rigid sheet metal venting material will be used in accordance with manufacturer specifications Dryer ducts exceeding 35' in duct equivalent length will have a dryer booster fan installed Plastic venting material will not be used Uninsulated clothes dryer duct will not pass through unconditioned spaces such as attics and crawl spaces Ducts will be connected and sealed as follows: • UL listed foil type or semi-rigid sheet metal to rigid metal will be fastened with clamp • Other specialized duct fittings will be fastened in accordance with manufacturer specifications • In addition to mechanical fasteners, duct connections will be sealed with UL 181B or 181B-M listed material In addition: • Sheet metal screws or other fasteners that will obstruct the exhaust flow will not be used • Condensing dryers will be plumbed to a drain	Preserve integrity of building envelope Effectively move air from clothes dryer to outside
6.6005.1b	Termination fitting	Termination fitting manufactured for use with dryers will be installed A backdraft damper will be included, as described in termination fitting detail	Preserve integrity of building envelope Effectively move air from clothes dryer to outside
6.6005.1c	Make-up air	Make-up air will be provided for appliances exhausting more than 200 CFM	Preserve integrity of building envelope Effectively move air from clothes dryer to outside
6.6005.1d	Combustion safety	Pressure effects caused by fans will be assessed and corrected when found outside of combustion safety standards	Ensure safe operation of combustion appliances Ensure occupant health and safety
6.6005.1e	Occupant education	Occupant will be instructed to keep lint filter and termination fitting clean Occupant will be instructed to keep dryer booster fan clean, if present Occupant will be instructed on clothes dryer operation safety including information on items that must not be placed in the clothes dryer (items with any oil or other flammable liquid on it, foam, rubber, plastic or other heat-sensitive fabric, glass fiber materials)	Effectively move air from clothes dryer to outside

6.6005.2 Kitchen Range

Topic: Exhaust
Subtopic: Appliance Exhaust Vents
6.6005.2 Detail Name: Kitchen Range
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 reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
6.6005.2a	Wiring	Wiring will be installed in accordance with local regulations or the 2012 IRC in the absence of such regulations or where those regulations are not as stringent as the 2012 IRC Wiring will be installed in accordance with original equipment manufacturer specifications and local and national electrical and mechanical codes	Prevent an electrical hazard
6.6005.2b	Fan venting	Kitchen range fans will be vented to the outdoors Re-circulating fans will not be used as a ventilating device	Remove cooking contaminants from the house Preserve integrity of building envelope
6.6005.2c	Fan ducting	Kitchen range fans will be ducted to the outdoors As short a run as practical of smooth wall metal duct will be used, following manufacturer specifications Ducting will be connected and sealed as follows: • Metal-to-metal will be fastened with a minimum of three equally spaced screws • Other metal-to-metal connections will be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems, or tapes • For down-draft exhaust systems, PVC-to-PVC materials will be fastened with approved PVC cement • Other specialized duct fittings will be fastened in accordance with manufacturer specifications • In addition to mechanical fasteners, duct connections will be sealed with UL 181B or 181B-M listed material	Preserve integrity of building envelope Effectively move air from range to outside
6.6005.2d	Termination fitting	Termination fitting will be installed including a backdraft damper, as described in termination fitting detail	Ensure safe operation of combustion appliances Ensure occupant health and safety
6.6005.2e	Make-up air	Make-up air will be provided for kitchen range fans exhausting more than 200 CFM	Ensure safe operation of combustion appliances Ensure occupant health and safety
6.6005.2f	Combustion safety	Pressure effects caused by fans will be assessed and corrected when found outside of combustion safety standards	Ensure safe operation of combustion appliances Ensure occupant health and safety
6.6005.2g	Occupant education	Occupant will be instructed to keep grease filters and termination fitting clean	Effectively move air from kitchen range to outdoors

6.6102.1 Outside Air Ventilation Supply Ducts

Topic: Supply
Subtopic: Components
6.6102.1 Detail Name: Outside Air Ventilation Supply Ducts
Desired Outcome: Ventilation supply ducts effectively move the required amount of air and prevent condensation

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
6.6102.1a	Duct design and configuration	Ventilation ducts will be as short, straight, and smooth as possible Ventilation ducts will not be smaller than the connections to which they are attached	Effectively move the required volume of air
6.6102.1b	Duct insulation	Ventilation supply ducts installed outside of the thermal envelope will be insulated to a minimum of R-8 or equivalent to local codes	Prevent moisture condensation
6.6102.1c	Duct support	Flexible and duct board ducts and plenums will be supported every 4′ using a minimum of 1 ½″ wide material Support materials will be applied in a way that does not crimp ductwork or cause the interior dimensions of the ductwork to be less than specified (e.g., ceiling, framing, strapping); duct support must be installed in accordance with authority having jurisdiction Metal ducts will be supported by 1/2″ or wider 18-gauge strapping or 12 gauge or thicker galvanized wire no less than 10′ apart	Effectively move the required volume of air Preserve integrity of the ventilation supply duct system Eliminate falling and sagging
6.6102.1d	Duct connections	All connections will have a contact overlap of at least 1″ Ducts will be connected and sealed as follows: • Round metal-to-metal or metal-to-PVC will be fastened with a minimum of three equally spaced screws • Other metal-to-metal or metal-to-PVC connections will be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded- fabric systems, or tapes • Flexible duct-to-metal or flexible duct-to-PVC will be fastened with tie bands using a tie band tensioning tool • Flexible duct between the cable tie and end of metal or PVC duct will be screwed • PVC-to-PVC materials will be fastened with approved PVC cement • Other specialized duct fittings will be fastened in accordance with manufacturer specifications Outdoor air ventilation supply ducts attached to the return side of forced air systems will be: • Attached as close to the heating, ventilation, and air conditioning (HVAC) systems fan as possible while remaining in compliance with manufacturer specifications • Set up to provide filtration of outdoor ventilation air before reaching the HVAC system (for minimum MERV 6 filter) • Attached via a mechanically fastened takeoff collar All joints and connections in ductwork will be fastened and sealed with UL181B or 181B-M welds, gaskets, adhesive mastics, or mastic-plus-embedded-fabric systems	Effectively move the required volume of air Preserve integrity of the ventilation supply duct system and building envelope
6.6102.1e	Duct materials	Flexible air duct material will meet UL 181, NFPA 90A/90B, International Mechanical Code, or the Uniform Mechanical Code	Effectively move the required volume of air Preserve integrity of the duct system and building envelope
6.6102.1f	Outdoor air intake location	Outdoor air intake will be installed in accordance with the following: • A minimum of 6″ from grade • A minimum of 10′ from contaminant sources or exhaust outlets • Above local snow or flood line • A minimum of 18″ above an asphalt based roof • Never on a flat roof • As required by authority having jurisdiction	Prevent contaminants from entering house Ensure unrestricted air flow

6.6102.2 Intakes

Topic: Supply
Subtopic: Components
6.6102.2 Detail Name: Intakes
Desired Outcome: Intake optimizes air flow while limiting the entry of insects, debris, and contaminants

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
6.6102.2a	Hole in building shell	A hole no greater than a 1/4" greater than the fitting will be cut to accommodate intake fitting	Ensure a weather tight installation
6.6102.2b	Intake fitting	Collar will be at least the same diameter as the duct; if collar is larger than duct, a rigid metal transition will be used Fitting will be appropriate for regional weather conditions and installation location on house so as not to be rendered inoperable	Effectively draw the required volume of air from the outdoors Preserve integrity of the building envelope Ensure durable installation
6.6102.2c	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
6.6102.2d	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
6.6102.2e	Connection to intake fitting	Duct to intake fitting will be connected and sealed as follows: • Round metal-to-metal or metal-to-PVC will be fastened with a minimum of three equally spaced screws • Other metal-to-metal or metal-to-PVC connections will be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems, or tapes • Flexible duct-to-metal or flexible duct-to-PVC will be fastened with tie bands using a tie band tensioning tool • Flexible duct between tie band and end of metal or PVC duct will be screwed into place • PVC-to-PVC materials will be fastened with approved PVC cement • Other specialized duct fittings will be fastened in accordance with manufacturer specifications • In addition to mechanical fasteners, duct connections will be sealed with UL 181B or 181B-M listed material Ensure fasteners do not inhibit intake damper operation	Preserve integrity of the building envelope Ensure a weather tight and durable intake installation Ensure unrestricted air flow
6.6102.2f	Weatherproofing	Exterior termination fitting will be flashed or weather sealed Water will be directed away from penetration Installation will not inhibit damper operation Manufacturer specifications will be followed	Preserve integrity of the building envelope Ensure a weather tight and durable intake installation Ensure unrestricted air flow
6.6102.2g	Pest exclusion	Corrosion resistant screen, louver, or grille material no less than ¼" and no greater than ½" hole size in any direction will be used, or as specified by authority having jurisdiction Screen will be installed so it does not inhibit intake damper operation	Prevent pest entry Ensure unrestricted air flow
6.6102.2h	Intake location	Intake will be installed according to the following: • A minimum of 6" from grade • A minimum of 10' from contaminant sources or exhaust outlets • Above local snow or flood line • A minimum of 18" above an asphalt based roof • Never on a flat roof • As required by authority having jurisdiction	Prevent contaminants from entering house Ensure unrestricted air flow

6.6102.3 Intake for Ventilation Air to Forced Air System Used for Heating or Cooling

Topic: Supply
Subtopic: Components
6.6102.3 Detail Name: Intake for Ventilation Air to Forced Air System Used for Heating or Cooling
Desired Outcome: Intake reduces pollutant entry, is easily maintained, has proper flow, and enhances house durability

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

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
6.6102.3a	Forced air system requirements	Existing forced air system leakage to outside will be less than 10% of the air handler flow when measured at 25 pascals with reference to outside Any portion of the return located inside the combustion appliance Zone will be air sealed	Reduce migration of pollutants
6.6102.3b	Wiring	Wiring will be installed in accordance with original equipment manufacturer specifications and local and national electrical and mechanical codes	Prevent an electrical hazard
6.6102.3c	Access	Motorized damper and service switch will be accessible for maintenance in accordance with required code or authority having jurisdiction	Ensure accessibility for maintenance
6.6102.3d	Mounting intake duct	Ventilation duct will be attached as close to the HVAC system's fan as possible while remaining in compliance with HVAC manufacturer specifications Filtration of ventilation air will be provided before passing through the thermal conditioning components Duct will be connected to intake fitting Connection and seal will be performed according to supply duct detail	Ensure short duct run to achieve optimum air flow Preserve integrity of the duct system and building envelope
6.6102.3e	Motorized damper	A motorized damper or equivalent technology will be installed between the intake fitting and the return side of the air handler Air flow will be provided by sequenced operation of the damper or equivalent technology	Prevent air flow when none is desired
6.6102.3f	Intake filter	An accessible filter will be installed Filter will be able to remove contaminants consistent with at least minimum efficiency reporting value (MERV) 6 or better when tested in accordance with ANSI/ASHRAE 52.2-2007 Filter or air cleaning systems that intentionally produce ozone will not be allowed	Ensure occupant health and safety Preserve integrity of the building envelope
6.6102.3g	Occupant education	Occupant will be educated on how and when to change filter	Protect occupant health and safety Preserve integrity of the building envelope

6.6103.1 Inline or Multi-Port

Topic: Supply
Subtopic: Fans
6.6103.1 Detail Name: Inline or Multi-Port
Desired Outcome: Inline or multi-port fan installed in accordance with specifications

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

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
6.6103.1a	Wiring	Wiring will be installed in accordance with original equipment manufacturer specifications, and local and national electrical and mechanical codes	Prevent an electrical hazard
6.6103.1b	Access	Fan and service switch will be accessible for maintenance, service, and replacement in accordance with applicable code or authority having jurisdiction	Ensure accessibility for maintenance
6.6103.1c	Fan mounting	Fan will be oriented with inlet toward the fan intake fitting Fan will be oriented so the equivalent length of the duct run is as short as possible Fan will be securely mounted in accordance with manufacturer specifications Fan will be isolated from the building framing unless specifically designed to be directly attached Fan will be installed remotely by ducting from supply register or grilles	Ensure short duct run to achieve optimum air flow Ensure fan is mounted securely Ensure fan housing or building framing does not shake, rattle, or hum when operating Minimize noise
6.6103.1d	Damper (required for intermittent operation)	Damper will be installed to open in the direction of the desired flow Damper will close when system is off	Ensure unrestricted air flow
6.6103.1e	Duct connections	Ducts will be connected and sealed to the intake fitting, fan, and register or grilles as follows: • Metal-to-metal or metal-to-PVC will be fastened with a minimum of three equally spaced screws • Flexible duct-to-metal or flexible duct-to-PVC will be fastened with tie bands using a tie band tensioning tool • Flexible duct between the cable tie and end of metal or PVC duct will be screwed • PVC-to-PVC materials will be fastened with approved PVC cement • Other specialized duct fittings will be fastened in accordance with manufacturer specifications All joints and connections in ductwork will be fastened and sealed with UL 181B or 181B-M welds, gaskets, adhesive mastics, or mastic-plus-embedded-fabric systems	Provide desired air flow Preserve integrity of the duct system and building envelope
6.6103.1f	Filter	An accessible filter will be installed between the intake fitting and the fan Contaminant removal will be consistent with at least minimum efficiency reporting value (MERV) 6 or better when tested in accordance with ANSI/ASHRAE 52.2 Filter or air cleaning systems that intentionally produce ozone will not be allowed	Ensure occupant health and safety Preserve integrity of the building envelope
6.6103.1g	Occupant education	Occupant will be educated on how and when to change filter	Ensure occupant health and safety
6.6103.1h	Boot to interior surface seal	All gaps between boot and interior surface will be air sealed Gypsum edge will be wetted before applying water-based sealant Sealants will be continuous and be in accordance with 2012 IRC R302.9	Prevent air leakage around intake housing Ensure a permanent seal to the building air barrier Prevent a fire hazard

6.6188.1 Removing Supply Vents from Garages

Topic: Supply
Subtopic: Special Considerations
6.6188.1 Detail Name: Removing Supply Vents from Garages
Desired Outcome: Safe removal of supply garage vents

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
6.6188.1a	Removal of supply/return in garage	Supply run feeding the register will be truncated as near to the supply plenum as possible If directly connected to the plenum, 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 Return grille located in garage will be removed in the same manner as supply	Minimize surface area of duct
6.6188.1b	Patching of the hole in the duct system created by removal	All holes in sheet metal ducts will be patched with sheet metal and secured with sufficient screws to hold the patch flat without gaps Holes left in any Y or T will be capped with sheet metal caps and fastened with at least three screws	Ensure a secure and strong patch
6.6188.1c	Sealing of the patch	All patches will be sealed with mastic meeting UL 181M and in accordance with manufacturer specifications	Ensure an airtight patch
6.6188.1d	Removal of discarded ducts	All abandoned ductwork will be removed from work area	Provide a clean work site
6.6188.1e	Patching of the register hole in garage	Hole created by the removal of the register and boot will be patched and taped using material meeting local codes	Prevent a fire hazard
6.6188.1f	External static pressure testing	Units will be tested for external static pressure (ESP) before and after work If there is a significant rise in ESP, air flow testing will be required	Ensure correct fan performance

6.6201.1 Installed System Air Flow

Topic: Whole Building Ventilation
Subtopic: Air Flow Requirements
6.6201.1 Detail Name: Installed System Air Flow
Desired Outcome: Installed system air flow meets required standard

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
6.6201.1a	Separate exhaust for all baths and kitchens plus primary ventilation	Air flows will be measured and adjusted to meet the following requirements: Bath: • 20 CFM continuous OR • 50 CFM intermittent Kitchen: • Minimum 100 CFM intermittent Primary ventilation: • Air flow rate will be no less than 7.5 CFM per person + 1 CFM per 100 square feet floor area of conditioned space = continuous use (minimum number of people = number of bedrooms plus one) For intermittent, use ASHRAE 62.2-2010	Provide sufficient flows in accordance with current ventilation standards
6.6201.1b	Separate exhaust for all baths and kitchens sufficient to meet primary ventilation requirements	Air flows will be measured and adjusted to meet the following requirements: Bath: • 20 CFM continuous OR • 50 CFM intermittent Kitchen: • Minimum 100 CFM intermittent • Air flow through bath or kitchen fan rated at 1 sone or less will be no less than 7.5 CFM per person + 1 CFM per 100 square feet = continuous use (minimum number of people = number of bedrooms plus one) For intermittent, use ASHRAE 62.2-2010	Provide sufficient flows per current ventilation standards
6.6201.1c	Single additional fan to meet all ventilation requirements	Air flows will be measured and adjusted to meet the following requirements: For continuous use: • 7.5 CFM per person + 1 CFM per 100 square feet, with adjustments • Refer to Appendix A of ASHRAE 62.2-2010 for additional assistance in meeting ventilation flows (minimum number of people = number of bedrooms plus one) For intermittent, use ASHRAE 62.2-2010	Provide sufficient flows in accordance with current ventilation standards

6.6201.2 Primary Ventilation Air Flow between Rooms

Topic: Whole Building Ventilation
Subtopic: Air Flow Requirements
6.6201.2 Detail Name: Primary Ventilation Air Flow between Rooms
Desired Outcome: Air circulates freely between rooms

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
6.6201.2a	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 outdoors with all interior doors closed and ventilation systems running	Ensure free flow of air between rooms Preserve integrity of the building envelope

6.6202.1 Controls

Topic: Whole Building Ventilation
Subtopic: Components
6.6202.1 Detail Name: Controls
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.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
6.6202.1a	Primary ventilation fan (whole-house volume)	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	Deliver intended air exchange Ensure fan controls meet intended ventilation strategy
6.6202.1b	Local exhaust—local 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
6.6202.1c	Wiring	Wiring will be installed in accordance with original equipment manufacturer specifications, and local and national electrical and mechanical codes	Prevent an electrical hazard Ensure fan controls meet intended ventilation strategy
6.6202.1d	Manual override	A labeled switch for manual override will be included for the ventilation system	Ensure fan controls meet intended ventilation strategy
6.6202.1e	Occupant education	A system operation guide designed for occupants (non-professionals) will be provided to explain how and why to operate system A label indicating the presence and purpose of the ventilation system will be included or a copy of the system operation guide will be posted at the electrical panel	Educate occupants about system operation and importance Deliver intended air exchange

6.6202.2 Heat Recovery Ventilator (HRV) and Energy Recovery Ventilator (ERV Installation

Topic: Whole Building Ventilation
Subtopic: Components
6.6202.2 Detail Name: Heat Recovery Ventilator and Energy Recovery Ventilator Installation
Desired Outcome: HRV and ERV systems installed to specifications

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

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
6.6202.2a	Wiring	Wiring will be installed in accordance with original equipment manufacturer specifications, and local and national electrical and mechanical codes	Prevent an electrical hazard
6.6202.2b	Access	Fans, service switch, filters, drain, and drain pan will be accessible for maintenance in accordance with authority having jurisdiction	Maintain designed air flows and system performance Ensure occupant health and safety
6.6202.2c	Fan mounting	Fan will be securely mounted in accordance with manufacturer specifications Fan will be oriented so the equivalent length of the duct run is as short as possible; calculate "equivalent length" in accordance with ANSI/ACCA Manual D – 2009 (Residential Duct Systems) 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
6.6202.2d	Backdraft dampers (required for intermittent operation)	A backdraft damper will be installed between the heat recovery ventilator (HRV) or energy recovery ventilator (ERV) and the exterior, unless the system operates continuously Outdoor air intakes and exhausts will be equipped with automatic or gravity dampers that close when the ventilation system is not operating	Prevent reverse air flow when the system is off
6.6202.2e	Installation of fittings	Collar will be at least the same diameter as the exhaust fan outlet; if collar is larger than exhaust fan outlet, a rigid metal transition will be used Fitting will be appropriate for regional weather conditions and installation location on house so as not to be rendered inoperable	Achieve the desired air flows to and from the designated locations Ensure unrestricted air flow Preserve integrity of the building envelope
6.6202.2f	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 as follows: • Metal-to-metal or metal-to-PVC will be fastened with a minimum of three equally spaced screws • Flexible duct-to-metal or flexible duct-to-PVC will be fastened with tie bands using a tie band tensioning tool • Flexible duct between tie band and end of metal or PVC duct will be screwed into place • PVC-to-PVC materials will be fastened with approved PVC cement • Other specialized duct fittings will be fastened in accordance with manufacturer specifications • In addition to mechanical fasteners, duct connections will be sealed with UL 181B or 181B-M listed material	Achieve the desired air flows to and from the desired locations Preserve integrity of the duct system and building envelope
6.6202.2g	Duct layout	Air to be exhausted to the outdoors will not be taken directly from the forced air system Supply ducts attached to the return side of forced air systems will be: • Attached as close to the 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 with minimum MERV 6 filter • Connected to the intake fitting • Connected and sealed in accordance with the supply duct detail	Achieve the desired air flows to and from the desired locations Preserve integrity of duct system and house Ensure occupant health and safety
6.6202.2h	Insulation	Ducts installed outside of the thermal envelope will be insulated to a minimum of R-8 or equivalent to local codes	Preserve integrity of the duct system by eliminating condensation

6.6202.2i	Sealant selection	Gap between registers or grilles and interior surface will be sealed Sealants will be compatible with their intended surfaces Sealants will be continuous and meet fire barrier specifications	Prevent air leakage around registers or grilles Ensure a permanent seal Prevent a fire hazard
6.6202.2j	Balance and flow	Air flows will be measured and adjusted to match to the system's intent	Achieve the desired air flows to and from the desired locations
6.6202.2k	Occupant education	Occupant will be educated on how and when to change filter and clean drain pan, if applicable, according to manufacturer specifications	Ensure occupant health and safety Preserve integrity of system

6.6203.1 Ventilator Dehumidifiers

Topic: Whole Building Ventilation
Subtopic: Dehumidifiers
6.6203.1 Detail Name: Ventilator Dehumidifiers
Desired Outcome: Humidity controlled to achieve optimum indoor air quality (IAQ)

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
6.6203.1a	Equipment	Equipment will be ENERGY STAR® rated 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
6.6203.1b	Sizing	System with enough capacity to handle humidity from outside air ventilation and internal gains will be selected Humidity levels inside the home will be maintained less than 60%	Efficiently remove humidity
6.6203.1c	Location	Equipment will be located in an area with access to HVAC supply trunk line or plenum and ducted outdoor air Access for maintenance, electrical service, and removal of condensate will be provided	Distribute outside air Easily maintain equipment
6.6203.1d	Installation	Installation will be in accordance with manufacturer specifications and local codes	Maintain manufacturer warranty and proper installation
6.6203.1e	Duct connections	Duct connections will be sized, sealed, and attached in accordance with manufacturer specifications	Achieve the desired air flows to and from the desired locations
6.6203.1f	Controls	Humidity control and sensor will be installed in accordance with manufacturer specifications near thermostat	Ensure humidity in the house controls the system operation

6.6288.1 Sound-Rating Limits

Topic: Whole Building Ventilation
Subtopic: Special Considerations
6.6288.1 Detail Name: Sound-Rating Limits
Desired Outcome: Systems operate as quietly as possible

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
6.6288.1a	Primary ventilation system or any continuously operating fan	System shall be rated for sound at a maximum of 1.0 sone, in accordance with ASHRAE 62.2-2010	Minimize noise
6.6288.1b	Intermittent local ventilation system	Local ventilation will be rated for sound at a maximum of 3 sone, unless their maximum rated airflow exceeds 400 cfm, in accordance with ASHRAE 62.2-2010	Minimize noise

6.9901.1 Supplemental Ventilation Information—ASHRAE 62.2

Topic: Ventilation—Additional Resources
Subtopic: Codes and Standards Resources
6.9901.1 Detail Name: Supplemental Ventilation Information—ASHRAE 62.2
Desired Outcome: To provide supplemental ventilation information—ASHRAE 62.2

For supporting reference material, see Appendix C.

Adjustments to primary ventilation fan flow rate, including infiltration credit and ASHRAE Standard 62.2-2010, Appendix A (calculation for alternative compliance for existing houses using a single fan).

Section 7: Baseload

7.8001.1 Refrigerator and Freezer Replacement

Topic: Plug Load
Subtopic: Refrigerators/Freezers
7.8001.1 Detail Name: Refrigerator and Freezer Replacement
Desired Outcome: A more energy efficient appliance installed

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
7.8001.1a	Selection	Appliance will have an efficiency level of at least 40% better than minimum federal requirements Appliance will fit in the available space without blocking access to light switches, cabinets, etc. Appliance will carry a minimum one-year warranty that will provide a replacement appliance if repeated issues relating to health, safety, or performance occur	Ensure occupant satisfaction with appliance
7.8001.1b	Installation	Appliance will be installed in accordance with manufacturer specifications and local codes Any penetrations to the exterior of the home created by the installation of the appliance will be sealed Energy-related appliance controls will be demonstrated to the occupant Specific information on the proper maintenance of the equipment will be provided to the occupant Warranty information, operation manuals, and installer contact information will be provided to the occupant	Achieve intended appliance function Preserve food at low energy use Educate occupant on how to operate and maintain the appliance
7.8001.1c	Decommissioning	Appliances replaced by new units will be recycled or disposed of in accordance with federal, state, or local regulations Appliances infested with pests will be enclosed before moving	Prevent reuse of inefficient equipment and components Protect the environment Protect worker safety

7.8001.2 Cleaning and Tuning Existing Refrigerators and Freezers

Topic: Plug Load
Subtopic: Refrigerators/Freezers
7.8001.2 Detail Name: Cleaning and Tuning Existing Refrigerators and Freezers
Desired Outcome: Energy used for food preservation reduced

For supporting reference material, see Appendix C.

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

7.8002.1 Entertainment and Computer Systems and Components Replacement

Topic: Plug Load
Subtopic: Electronics
7.8002.1 Detail Name: Entertainment and Computer Systems and Components Replacement
Desired Outcome: Energy used for electronic entertainment and computer use reduced while effective performance is maintained

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
7.8002.1a	Selection	Category of equipment selected will meet occupant preferences and have the lowest available energy use [e.g., plasma vs. light-emitting diode (LED)] Equipment will have a minimum energy efficiency level of ENERGY STAR® Equipment will be selected that does not have to be left on during non-use periods for updates (e.g., gaming systems, set-top boxes) Standby losses for system will be one watt or less	Reduce energy use Ensure occupant satisfaction with appliance
7.8002.1b	Installation	Equipment will be installed in accordance with manufacturer specifications (e.g., air circulation) and meet all applicable codes Any penetrations to the exterior of the home created by the installation of the equipment will be sealed All energy saving features will be enabled unless specifically directed otherwise by the occupant A readily accessible means of disconnection (e.g., power strip, timer) will be provided for equipment that must be disconnected from the power source to avoid standby losses and whose performance will not be damaged by being disconnected All equipment controls will be demonstrated to the occupant Specific information about the proper maintenance of the equipment will be provided to the occupant Warranty information, operation manuals, and installer contact information will be provided to the occupant	Reduce energy use Ensure equipment is available for use when needed Ensure equipment is convenient to turn off when not in use Educate occupant on how to operate and maintain equipment
7.8002.1c	Decommissioning	Equipment will be recycled or disposed of using Environmental Protection Agency (EPA) Responsible Recycling (R2) initiative principles	Prevent reuse of inefficient equipment and components Reduce waste Properly dispose of hazardous materials

7.8003.1 Lighting Upgrade

Topic: Plug Load
Subtopic: Lighting
7.8003.1 Detail Name: Lighting Upgrade
Desired Outcome: Energy used for lighting reduced while maintaining adequate and safe lighting levels

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
7.8003.1a	Day lighting	Window coverings (e.g., blinds, shades, moveable insulation) will be replaced or maneuvered to maximize useful daylight where appropriate Active and passive day lighting will be properly oriented, designed, and installed where appropriate	Reduce energy use without negative consequences (e.g., glare, unintentional heating)
7.8003.1b	Selection	All bulbs, fixtures, and controls will be appropriate for the intended application (e.g., enclosed, orientation, dimmable, potential for breakage, indoor, and outdoor) All bulbs, fixtures, and controls will be selected to provide the brightness and light quality required in that application (e.g., task lighting, trip-and-fall hazards, nightlights) Selected equipment should have the highest level of efficiency within a technology [e.g., compact fluorescent lamp (CFL), LED] All bulbs, fixtures, and controls will be ENERGY STAR® rated where applicable When possible, bulbs, fixtures, and controls will be selected that will facilitate the use of future lighting technologies (e.g., LEDs) When incandescent bulbs cannot be replaced or when occupant chooses not to replace, a dimmer will be selected Power quality will be evaluated before new lighting is selected Light/lamp wattage should not exceed rated wattage of fixture Bulb replacements will be chosen based on expected durability, light quality, and lifetime energy use of the bulb Controls to turn off lights when not needed (e.g., no one in room) will be provided All bulbs, fixtures, and controls will be UL-approved and installed in accordance with local code(s) and NFPA 70 National Electric Code Fluorescent light ballasts containing polychlorinated biphenyls (PCBs) will be replaced in accordance with the EPA's Healthy Indoor Environment Protocols for Home Energy Upgrades	Provide improved lighting quality at lower energy use Select equipment that will not be an unnecessary barrier to future technologies Avoid inferior products and unsatisfied occupants

7.8004.1 Washing Machine

Topic: Plug Load
Subtopic: Laundry
7.8004.1 Detail Name: Washing Machine
Desired Outcome: Energy and environmental impact for washing clothes reduced

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

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
7.8004.1a	Selection	Minimum appliance efficiency will be ENERGY STAR® and WaterSense® or better Classes within ENERGY STAR standards will be considered so as to achieve greater savings Adequate clearance will be maintained around appliance when fit into available space so access to cabinets and light switches are not blocked Appliance will be covered by a minimum one-year warranty Equipment will be selected with features that reduce peak electric demand, absolute energy use, and water use Standby losses for equipment will be one watt or less	Reduce energy use Ensure occupant satisfaction with appliance
7.8004.1b	Installation	Appliance will be installed in accordance with manufacturer specifications (e.g., leveling, plumbing connection, electrical connection, interior lighting) and meet all applicable codes Shut-off valves will be installed if not already present Hoses that can withstand water pressure at the location will be installed If located in conditioned or finished area, overflow pan will be installed and drained to a safe location Any penetrations to the exterior of the home created by the installation of the appliance will be sealed Energy-related appliance controls will be demonstrated to the occupant Specific information about proper maintenance of the equipment will be provided to the occupant Water quality will be evaluated using a pH and hardness tests, and the occupant will be informed on detergent levels and type to optimize performance Warranty information, operation manuals, and installer contact information will be provided to the occupant	Ensure equipment functions as designed Reduce water consumption Prevent water damage Educate occupants on how to maintain washer to ensure savings
7.8004.1c	Decommissioning	Replaced appliances will be recycled or removed in accordance with local regulations, including older equipment switches containing mercury	Prevent the reuse of inefficient equipment and its components Reduce waste Ensure occupant health

7.8004.2 Clothes Dryer Replacement

Topic: Plug Load
Subtopic: Laundry
7.8004.2 Detail Name: Clothes Dryer Replacement
Desired Outcome: Energy and environmental impact for drying clothes reduced

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
7.8004.2a	Selection	Total energy use will be factored into the selection process if fuel switching is being considered Dryer will be equipped with moisture sensor Equipment will be selected with energy features that reduce both peak electric demand and absolute energy use Standby losses for equipment will be one watt or less A dryer best matched to the venting options will be selected (e.g., central location, length of vent, cost of venting) Appliance will be covered by a minimum one-year warranty	Reduce energy use Avoid increasing total energy use (gas and electric) when fuel switching
7.8004.2b	Installation	Appliance will be installed in accordance with manufacturer specifications (e.g., leveling, plumbing connection, electrical connection, interior lighting) and meet all applicable codes If existing venting does not meet the following criteria (as well as manufacturer specifications and applicable codes), new venting will be installed using the following specifications: • Appliance will be vented to the outside using metal-to-metal or UL listed foil-type venting material • Venting design will meet standards for optimal venting • Venting will not be constricted or blocked • Only screws will be used to connect metal-to-metal and must not catch lent inside venting material • Only clamps will be used on semi-rigid metal and UL listed foil-type venting materials • Pest screen will be installed at the termination • At least 3' of the vent closest to the exterior of the house will be insulated with a minimum of R-6 All dryers, other than condensing dryers, will be vented to the outdoors If a combustion appliance is used, combustion safety testing will be performed in accordance with the Health and Safety Chapter of the Standard Work Specifications for Single Family Housing or other equivalent practice Any penetrations to the exterior of the home created by the installation of the appliance will be sealed Energy-related appliance controls will be demonstrated to the occupant Specific information of the proper maintenance of the equipment will be provided to the occupant Warranty information, operation manuals, and installer contact information will be provided to the occupant	Ensure equipment functions as designed Install appliance safely and effectively Ensure house as a whole system is not adversely affecting the proper functioning/venting of equipment Reduce energy use In case of fuel switching, reduce cost
7.8004.2c	Decommissioning	Replaced appliances will be recycled or removed and disposed of in accordance with local regulations, including older equipment switches containing mercury	Prevent the reuse of inefficient equipment and its components Reduce waste Ensure occupant health

7.8101.1 Shower Head and Faucet Aerator

Topic: Water Heating
Subtopic: Water Use Reduction
7.8101.1 Detail Name: Shower Head and Faucet Aerator
Desired Outcome: Energy and water use reduced while occupant needs for water flow maintained

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

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
7.8101.1a	Work assessment	Installer pre-work assessment will be conducted to determine if plumbing needs correction before installing high-efficiency shower head or faucet	Verify scope of work
7.8101.1b	Selection	The rated flow of new shower heads will be 2.5 gallons per minute (GPM) or less If multiple heads are provided, the total flow rate will not exceed 2.5 GPM Aerator flow rate will be 2.2 GPM or less Features will be selected that meet any special needs of the occupant (e.g., shut off, swivel, handheld showers)	Reduce water and energy consumption Ensure occupant satisfaction
7.8101.1c	Installation	Equipment will be installed in accordance with manufacturer specifications and meet all applicable building codes Water quality will be evaluated for debris that may clog the equipment Once installed, high-efficiency shower heads or faucet aerators will be tested to determine if equipment is tightened adequately to prevent leakage at the point of connection If needed, shower diverter will be repaired or replaced Any penetrations to the exterior of the home created by the installation of the equipment will be sealed Any damage done to the house during installation will be repaired Specific information about proper maintenance of the equipment will be provided to the occupant Warranty information, operation manuals, and installer contact information will be provided to the occupant Water flow that satisfies the occupant will be provided by all shower heads and faucet aerators Occupant's acceptance of the shower head and/or aerator will be documented	Reduce water and energy consumption Ensure occupant satisfaction with water flow Eliminate water leakage Prevent water damage
7.8101.1d	Decommissioning	Replaced shower heads and faucet aerators will be recycled or disposed of properly	Prevent the reuse of inefficient equipment and components

7.8102.1 Water Heater Selection

Topic: Water Heating
Subtopic: Installation and Replacement
7.8102.1 Detail Name: Water Heater Selection
Desired Outcome: Safe, reliable, and efficient hot water source selected that meets occupant needs at lowest possible cost of ownership and operation

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
7.8102.1a	Selection parameters	Equipment will provide sufficient, affordable, safe, and healthy hot water for the occupant in accordance with 2012 IRC P2801 Potential for solar hot water heating or other renewable energy systems will be assessed in selecting the hot water equipment Potential for health and safety hazards (e.g., backdrafting, flame rollout, obstructions) will be assessed in selecting equipment and the cost of remedying such problems will be included in any cost and benefit calculations If a combustion based system is selected, it will be either direct vented or power vented, and ENERGYSTAR qualified If combustion equipment is selected, a low nitrogen oxide burner will be included Equipment will be functional at high efficiency under all load conditions Standby losses will be reduced to maximum potential Fuel type will be selected based on affordability to occupant Equipment will be freeze resistant or installed in a conditioned space Efficiency of equipment will be maintained throughout life of system Occupant control of hot water temperature will be provided on the equipment The following will be determined from the occupant: • Lifestyle • Current and future needs • Space considerations • Fuel options • Health and safety considerations • Appliance options • Maintenance and operation costs • Return on investment concerns	Save energy and water Protect the environment Identify appliance options based on the needs and wants of the occupant
7.8102.1b	Product selection	Water heater will be selected based on performance requirements of the occupant, available fuel sources, energy efficiency, and total life cycle cost In very cold climates, on-demand water heaters will be sized to meet the demand of water flow at very low water intake temperatures When evaluating an existing thermal solar water heating system, a solar expert should be consulted The proper installation and maintenance of solar hot water systems is provided in the Uniform Solar Energy Code (USEC) and 2012 IRC Chapter 23	Ensure equipment meets the occupant's expectations while providing efficient energy and water use

7.8102.2 Storage-Type Appliance

Topic: Water Heating
Subtopic: Installation and Replacement
7.8102.2 Detail Name: Storage-Type Appliance
Desired Outcome: Safe and reliable hot water source provided that meets occupant needs at lowest possible cost of ownership

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

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
7.8102.2a	Hazardous material removal	Health concerns in the removal and replacement of equipment (e.g., asbestos, other hazardous materials) will be identified Written notification will be provided to occupants of the discovery of hazardous material, including contact information for regional EPA asbestos coordinator Occupant will be asked to contract with an EPA-certified asbestos contractor to conduct abatement before equipment removal and replacement (occupant is responsible for abatement or remediation)	Remediate health hazards using EPA-certified contractors
7.8102.2b	Equipment removal	Accepted industry procedures and practices will be followed to: • Remove old water heater and associated components in accordance with 2012 IRC R105.1 or authority having jurisdiction • Seal any unused chimney openings and penetrations in accordance with 2012 IRC N1102.4.1.1 or authority having jurisdiction • Remove unused oil tank, lines, valves, and associated equipment in accordance with 2012 IRC M2201.7 or authority having jurisdiction All work shall be completed by a licensed plumbing professional where required by the authority having jurisdiction and installed to industry-accepted standards	Ensure the safety of the workers and occupants Preserve integrity of the building Remove old equipment in a timely and efficient manner
7.8102.2c	New equipment installation	New water heater and associated components will be installed to accepted industry standards, in accordance with the 2012 IRC and manufacturer specifications The system will be installed to be freeze resistant Any existing water leaks will be repaired before installation begins Any penetrations to the exterior of the home created by the installation of the equipment will be sealed	Ensure the safety of the workers and occupants Preserve integrity of the building Remove old equipment in a timely and efficient manner
7.8102.2d	Emergency drain pan	An emergency drain pan will be installed with sides that extend a minimum of 4" above floor if leakage would cause damage to the home and in accordance with P2801.5 of the 2012 IRC A ¾" drainline or larger will be connected to tapping on pan and terminated in accordance with P2801.5.2 of the 2012 IRC	Collect and safely dispose of water escaping from the storage tank
7.8102.2e	Expansion tank	A potable water expansion tank will be installed on the cold water side A direct connection with no valves between the storage tank and expansion tank will be installed in accordance with the 2012 IRC, authority having jurisdiction, and according to manufacturer specifications	Protect the storage tank from expansion
7.8102.2f	Temperature and pressure relief valve	Correct temperature and pressure relief valve will be installed in compliance with P2803 of the 2012 IRC and according to manufacturer specifications Temperature and pressure relief valve discharge tube will be installed in accordance with P2803.6.1 of the 2012 IRC	Discharge excessive energy (pressure or temperature) from storage tank to safe location
7.8102.2g	Dielectric unions	Dielectric unions will be installed in accordance with the 2012 IRC, authority having jurisdiction, and according to manufacturer specifications	Break the stray voltage electrical circuit through the storage tank
7.8102.2h	Backflow prevention	Backflow prevention will be installed in accordance with manufacturer specifications and all applicable codes	Protect water supply from contamination

7.8102.2i	Thermal efficiency	If additional tank insulation is installed, it will be rated a minimum of R-11 and will be installed to manufacturer specifications 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
7.8102.2j	Fuel supply	Electric or fossil fuel supply components will be installed to accepted industry standards as per NFPA 31 and 54, or NFPA 70 National Electric Code (NEC) for electric components, or authority having jurisdiction	Provide sufficient fuel to the water heater, burner, or element
7.8102.2k	Discharge temperature	Discharge temperature will be set not to exceed 120° or as prescribed by local code	Ensure safe hot water supply temperature to fixtures
7.8102.2l	Commissioning of system	The following will be checked once the system has been filled and purged: • Safety controls • Combustion safety and efficiency • Operational controls • Fuel and water leaks • Local code requirements Commissioning will be in compliance with manufacturer specifications and relevant industry standards	Ensure safe system function Keep cost of ownership as low as possible
7.8102.2m	Occupant safety	Carbon monoxide (CO) alarms will be installed in each dwelling in accordance with ASHRAE 62.2 and authority having local jurisdiction Occupant will be provided information regarding the health effects and risk of high CO concentrations as well as a list of monitors that can provide more detail regarding CO levels	Ensure occupant life safety; CO alarms are designed to detect levels at which occupants might become unable to evacuate
7.8102.2n	Occupant education	Completed work will be reviewed Occupants will be educated on the safe and efficient operation and maintenance of the system, including: • Adjustment of water temperature and target temperature in accordance with local code • Periodic drain and flush • Expansion tank and backflow preventer (no occupant maintenance required) • Periodic inspection, maintenance, or replacement	Ensure occupant is informed of the safe, efficient operation and maintenance of the system

7.8102.3 On-Demand Appliance

Topic: Water Heating
Subtopic: Installation and Replacement
7.8102.3 Detail Name: On-Demand Appliance
Desired Outcome: Safe and reliable hot water source provided that meets occupant needs at lowest possible cost of ownership

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

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
7.8102.3a	Hazardous material removal	Health concerns in the removal and replacement of equipment (e.g., asbestos, other hazardous materials) will be identified Written notification will be provided to occupants of the discovery of hazardous material, including contact information for regional EPA asbestos coordinator Occupants will be asked to contract with an EPA-certified asbestos contractor to conduct abatement before equipment removal and replacement (occupant is responsible for abatement or remediation)	Remediate health hazards using EPA-certified contractors
7.8102.3b	Equipment removal	Accepted industry procedures and practices will be followed to: • Remove old water heater and associated components in accordance with 2012 IRC R105.1 • Seal any unused chimney openings and penetrations in accordance with 2012 IRC N1102.4.1.1 • Remove unused oil tank, lines, valves, and associated equipment in accordance with 2012 IRC M2201.7 All work shall be completed by a licensed plumbing professional where required by the authority having jurisdiction and installed to industry-accepted standards	Ensure the safety of the workers and occupants Preserve integrity of the building Remove old equipment in a timely and efficient manner
7.8102.3c	New equipment installation	A new water heater and associated components will be installed to accepted industry standards, in accordance with the 2012 IRC, authority having jurisdiction and manufacturer specifications	Ensure the safety of the workers and occupants Preserve integrity of the building Remove old equipment in a timely and efficient manner
7.8102.3d	Emergency drain pan	An emergency drain pan will be installed with sides that extend a minimum of 4" above floor if leakage would cause damage to the home and in accordance with P2801.5 of the 2012 IRC A ¾" drainline or larger will be connected to tapping on pan and terminated in accordance with P2801.5.2 of the 2012 IRC	Collect and safely dispose of water escaping from the storage tank
7.8102.3e	Temperature and pressure relief valve	Correct temperature and pressure relief valve will be installed in compliance with P2803 of the 2012 IRC and according to manufacturer specifications Temperature and pressure relief valve discharge tube will be installed in accordance with P2803.6.1 of the 2012 IRC	Discharge excessive energy (pressure or temperature) from storage tank to safe location
7.8102.3f	Dielectric unions	Dielectric unions will be installed to accepted industry standards, in accordance with the 2012 IRC and according to manufacturer specifications	Break the stray voltage electrical circuit through the storage tank
7.8102.3g	Backflow prevention and pressure regulator	Backflow prevention will be installed in accordance with manufacturer specifications House water pressure and volume will be verified as sufficient to be in accordance with manufacturer specifications All applicable codes will be followed	Protect the water supply from contamination Provide for sufficient volume and pressure
7.8102.3h	Thermal efficiency	Any accessible hot water lines at the appliance will be insulated to meet 2012 IRC N1103.4.2 or local requirements, whichever is greater.	Reduce line losses

7.8102.3i	Required combustion air	Recommendations will be made to install all on-demand appliances as sealed combustion If not possible: • Combustion and ventilation (excess air) requirements of gas-fired appliances, including provision of outside and inside air to account for building tightness, will be provided • The minimum required volume shall be 50 cubic feet per 1,000 Btu/h in accordance with 2012 IRC G2407.5.1 • If needed, additional combustion air will be provided in accordance with 2012 IRC G2407	Ensure adequate combustion air for operation of the appliance
7.8102.3j	Venting of flue gases	Combustion byproducts will be removed in accordance with Chapter 24 of the 2012 IRC, authority having jurisdiction, and manufacturer specifications	Ensure the safety and durability of the venting system
7.8102.3k	Flue gas testing	Undiluted flue gases will be checked with a calibrated combustion analyzer in accordance with BPI-1100-T-2012 If combustion is not in compliance with BPI-1100-T-2012, diagnostics and adjustments will be done to manufacturer specifications or local codes	Confirm that combustion is occurring safely with maximum efficiency
7.8102.3l	Electric and fossil fuel supply	Electric or fossil fuel supply components will be installed to accepted industry standards as per Chapter 24 of the 2012 IRC, NFGC and NFPA 31 and 54 for gas and oil, or NEC for electric Energy input required by the appliance will be in accordance with manufacturer specifications	Provide sufficient fuel to the water heater burner or element
7.8102.3m	Cold water supply	The volume and pressure of the water supplied to the appliance will be in accordance with manufacturer specifications	Provide sufficient volume and pressure of water to the appliance
7.8102.3n	Discharge temperature	Discharge temperature will be set in accordance with manufacturer instructions and in compliance with local codes Use extreme caution when temperature setting is above 120°F	Ensure safe hot water supply temperature to fixtures
7.8102.3o	Commissioning of system	The following will be checked once the system has been connected and filled: • Safety controls • Combustion safety and efficiency • Operational controls • Fuel and water leaks • Cycle unit • Local code requirements Manufacturer specifications and all relevant industry standards will be met in commissioning	Ensure system functions safely with lowest possible cost of ownership
7.8102.3p	Ambient carbon monoxide (CO)	All homes will have a CO alarm	Ensure occupant health and safety
7.8102.3q	Occupant education	Completed work will be reviewed Occupants will be educated on the safe and efficient operation and maintenance of the system, including: • Adjustment of water temperature and target temperature in accordance with local code • Operation of backflow preventer and pressure regulator (no occupant maintenance required) • Importance of keeping operating manuals accessible	Ensure occupant is informed of the safe, efficient operation and maintenance of the system

7.8103.1 Storage-Type Appliance

Topic: Water Heating
Subtopic: Maintenance Inspection
7.8103.1 Detail Name: Storage-Type Appliance
Desired Outcome: Safe, reliable, and efficient operation of the appliance maintained

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

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
7.8103.1a	Health and safety	Combustion safety testing will be performed in accordance with the Health and Safety Chapter of the Standard Work Specifications for Single Family Housing or other equivalent practice Electrical components will be verified to comply with NEC (e.g., no electrical box connector, no disconnect, improperly sized breaker and wire)	Identify potential health and safety issues
7.8103.1b	Visual inspection	Inspection will be conducted to show compliance with the 2012 IRC, including but not limited to: • Water or fuel leaks • Damaged wiring • Venting issues with draft and condensation (e.g., soot, rusting of flue pipe, burned paint or wires, efflorescence) • Corrosion (e.g., rust, mineral deposits) • General condition of components	Determine needed repairs or maintenance
7.8103.1c	Thermal efficiency	Water heater storage tanks shall have a minimum R-value of R-24 Added insulation will not obstruct the unit's draft diverter, pressure relief valve, thermostats, hi-limit switch, plumbing pipes or elements, and thermostat access plates The first 6' of inlet and outlet piping will be insulated in accordance with 2012 IRC N1103.4.2 or local requirements, whichever is greater	Reduce standby losses from near tank piping and storage tank Ensure insulation does not make contact with flue gas venting
7.8103.1d	Potable water expansion tank	A potable water expansion tank will be installed on the cold water side Tanks that leak or have excessive corrosion will be replaced A direct connection with no valves from the expansion tank to the storage tank will be installed Connection will be properly supported with strapping An expansion tank drain will be included in non-bladder tanks Tank will be installed to accepted industry standards, in accordance with the 2012 IRC and according to manufacturer specifications Tanks that are completely full of water will be drained and refilled before being replaced or repaired Expansion tanks with bladders will have air charged to the manufacturer pressure requirements while water is not present in the tank Bladder tanks with water inside of the air bladder will be replaced in accordance with manufacturer specifications	Absorb water expansion of the system
7.8103.1e	Temperature and pressure relief valve	Correct temperature and pressure relief valve will be installed in compliance with P2803 of the 2012 IRC and according to manufacturer specifications Temperature and pressure relief valve discharge tube will be installed in accordance with P2803.6.1 of the 2012 IRC	Discharge excessive energy (pressure or temperature) from storage tank to safe location
7.8103.1f	Maintenance records	Occupants will be advised to keep records of all maintenance done to their system Copies of or access to installation and operation manuals will be provided	Provide a history of system installation and maintenance to improve chance of successful future maintenance or repair

7.8103.1g	Occupant safety	Carbon monoxide (CO) alarms will be installed in each dwelling in accordance with ASHRAE 62.2 and authority having local jurisdiction Occupant will be provided information regarding the health effects and risk of high CO concentrations as well as a list of monitors that can provide more detail regarding CO levels	Ensure occupant life safety Inform occupant regarding possible CO hazards
7.8103.1h	Occupant education	Completed work will be reviewed Occupants will be educated on the safe and efficient operation and maintenance of the system, including: • Adjustment of water temperature and target temperature in accordance with local code • Periodic drain and flush • Periodic inspection, maintenance, or replacement of anode rod	Ensure occupant is informed of the safe, efficient operation and maintenance of the system

7.8103.2 On-Demand Appliance

Topic: Water Heating
Subtopic: Maintenance Inspection
7.8103.2 Detail Name: On-Demand Appliance
Desired Outcome: Safe, reliable, and efficient operation of the appliance maintained

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

For supporting reference material, see Appendix C.

ROW	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
7.8103.2a	Health and safety	Combustion safety testing will be performed in accordance with the Health and Safety Chapter of the Standard Work Specifications for Single Family Housing or other equivalent practice Electrical components will be verified to comply with NEC (e.g., no electrical box connector, no disconnect, improperly sized breaker and wire)	Identify potential health and safety issues
7.8103.2b	Visual inspection	Inspection will be conducted to show compliance with the 2012 IRC, including but not limited to: • Water or fuel leaks • Damaged or missing pipe insulation and tank insulation, where applicable • Damaged wiring • Venting issues with draft and condensation (e.g., soot, rusting of flue pipe, burned paint or wires, efflorescence) • Corrosion (e.g., rust, mineral deposits) • General condition of components	Determine needed repairs or maintenance
7.8103.2c	Temperature and pressure relief valve	Correct temperature and pressure relief valve will be installed in compliance with P2803 of the 2012 IRC and according to manufacturer specifications Temperature and pressure relief valve discharge tube will be installed in accordance with P2803.6.1 of the 2012 IRC	Discharge excessive energy (pressure or temperature) from storage tank to safe location
7.8103.2d	Flue gas testing	Undiluted flue gases will be checked with a calibrated combustion analyzer in accordance with BPI-1100-T-2012 If combustion is not in compliance with BPI-1100-T-2012, diagnostics and adjustments will be done to manufacturer specifications or local codes	Perform combustion testing

7.8103.2e	Required combustion air	If sealed combustion has not been installed: Combustion and ventilation (excess air) requirements of gas-fired appliances, including provision of outside and inside air to account for building tightness, will be provided The minimum required volume will be 50 cubic feet per 1,000 Btu/h in accordance with 2012 IRC G2407.5.1 If needed, additional combustion air will be provided in accordance with 2012 IRC G2407	Ensure adequate combustion air for operation of the appliance
7.8103.2f	Venting of flue gases	Condition of venting will be inspected in accordance with Section 504 IFGC for gas water heaters or NFPA 31 for oil water heaters	Verify proper venting of flue gases
7.8103.2g	Fuel supply	Condition of fuel supply components will be checked in accordance with NFPA 31 for oil, NFPA 54 for gas, NFPA 58 for propane, or NFPA 70 National Electric Code for electric, and authority having jurisdiction	Verify sufficient fuel to the water heater burner and element
7.8103.2h	Cold water supply	Water supplied to the appliance will be of sufficient volume and pressure to be in accordance with manufacturer specifications	Verify sufficient volume and pressure of water to the appliance
7.8103.2i	Discharge temperature	Discharge temperature will be set not to exceed 120°F or in accordance with local code, whichever is lower	Ensure safe hot water supply temperature to fixtures
7.8103.2j	Test the system safety and operation	The following will be tested: • Safety controls (e.g., water, air pressure switches) • Combustion safety and efficiency • Operational controls • Fuel and water leaks • Unit runs through complete cycle • Local code requirements Manufacturer specifications and all relevant industry standards will be met	Ensure system functions safely with lowest possible cost of ownership
7.8103.2k	Maintenance records	Occupants will be advised to keep records of all maintenance done to their system Copies of or access to installation and operation manuals will be provided	Improve chance of successful future maintenance or repair
7.8103.2l	Occupant health and safety	All homes will have a carbon monoxide (CO) alarm	Ensure occupant health and safety
7.8103.2m	Occupant education	Completed work will be reviewed Occupants will be educated on the safe and efficient operation and maintenance of the system, including: • Adjustment of water temperature • Target temperature in accordance with local code	Ensure occupant is informed of the safe, efficient operation and maintenance of the system

Appendices

Appendix A: Supplemental Ventilation Information

Adjustments to primary ventilation fan flow rate, including infiltration credit and ASHRAE Standard 62.2-2010, Appendix A (calculation for alternative compliance for existing houses using a single fan)

Calculation of the Infiltration Credit

The infiltration credit that can be used to reduce the required installed fan flow requires a series of calculations. These calculations can be reduced to a few inputs using certain assumptions. This section provides this reduced equation for infiltration and shows how to use this to determine the credit for infiltration. For a more detailed step-by-step discussion, see the end of this appendix.

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1) The infiltration rate at operating conditions, measured in CFM, can be estimated as

$$I_{CFM} = 0.0508 * w * S * Q_{50}$$

In this equation:

S is a factor accounting for the height of the house, determined from Table A-1
Q_{50} is the blower door test result in CFM50 (cubic feet per minute at 50 Pa)
w is the weather factor from ASHRAE Standard 136

Table A-1. S-Factors for Various House Heights

Number of stories	1	1.5	2	2.5	3
S-Factor	1	1.13	1.23	1.32	1.39

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2) The default infiltration rate I_d from ASHRAE Standard 62.2, measured in CFM, is

$$I_d = 0.02 * A_{floor}$$

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3) If I_{CFM} is greater than I_d, then the infiltration credit I_{cred} can be calculated as

$$I_{cred} = ½(I_{CFM} - I_d)$$

Use of ASHRAE Standard 62.2-2010, Appendix A

ASHRAE Standard 62.2-2010 includes an appendix that details an alternative compliance method intended for existing homes that did not meet the ASHRAE 62.2 local exhaust requirements when built. The strategy is to evaluate how much local exhaust deficit there is in each room that should have local exhaust, based on intermittent fan requirements, and to increase the continuous primary fan flow rate to account for this deficit. This section provides guidance on how to determine the increase to the primary fan flow rate to comply with ASHRAE 62.2-2010.

Per ASHRAE 62.2-2010

- Each bathroom should have a 50 CFM fan, if used intermittently.
- Each kitchen should have a 100 CFM fan, if used intermittently.

For each of these rooms that does not meet these requirements:

1) Calculate the deficit. If there is a fan that exhausts to the outside but does not have the required flow, the deficit is only the difference between the required flow and the measured flow.
2) Reduce the deficit by 20 CFM for each of these rooms that have an operable window.
3) Sum up all of the individual deficits.
4) Divide by 4.
5) Add the result to the required primary fan flow rate.

Example #1:

- Kitchen has no exhaust to outside but has an operable window.
- Bathroom #1 has no exhaust but has an operable window.
- Bathroom #2 has a fan that moves only 32 CFM.

Deficit for kitchen is 100-20 = 80 CFM (20 CFM credit for operable window)

Deficit for bathroom #1 is 50-20 = 30 CFM (20 CFM credit for operable window)

Deficit for bathroom #2 is 50-32 = 18 CFM

Sum of deficits is 80+30+18 CFM = 128 CFM

Increase required primary fan flow rate by 128/4 = 32 CFM

Example #2:

- Kitchen has a fan to outside that moves only 60 CFM and an operable window.
- Bathroom #1 has a fan that moves only 20 CFM.
- Bathroom #2 has a fan that moves only 32 CFM.

Deficit for kitchen is 100-60-20 = 20 CFM (20 CFM credit for operable window)

Deficit for bathroom #1 is 50-20 = 30 CFM

Deficit for bathroom #2 is 50-32 = 18 CFM

Sum of deficits is 20+30+18 CFM = 68 CFM

Increase required primary fan flow rate by 68/4 = 17 CFM

Detailed Step-by-Step Process for Determining Infiltration Credit

This process determines the infiltration credit using only a blower door result, three house characteristics (floor area, volume, number of above-grade stories), and a factor used to account for local weather.

The calculations that are required are for the equivalent leakage area (ELA), normalized leakage (NL), and infiltration (I) at normal operating conditions.

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1) Calculation of ELA

$$ELA = \frac{Q_{50}}{50_n}\ \Delta P^n \sqrt{\frac{\rho}{2\Delta P}}$$

Where:

- $\boldsymbol{Q_{50}}$ = blower door leakage at 50 Pa [ft³/min @ 50 Pa (or CFM50)]
- $\boldsymbol{n}$ = house leakage curve exponent
- $\boldsymbol{\Delta P}$ = reference pressure difference between inside and outside (Pa)
- $\boldsymbol{\rho}$ = density

By assuming that n = 0.65 (experimental average value for residential houses), ΔP = 4 Pa (typical reference value for ELA), and the density is a constant of 1.2 kg/m³, the ELA can be rewritten as, and by converting all metric units to consistent inch-pound (I-P) units:

$$ELA = 0.000381 * Q_{50}$$

(with Q_{50} measured as CFM50, ELA has units of ft²)

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2) Calculation of NL

$$NL = \frac{1000 * ELA}{A_{floor}} \left(\frac{H}{H_0}\right)^{0.3}$$

Where:

- $\boldsymbol{A_{floor}}$ = floor area of the house (ft²)
- $\boldsymbol{H}$ = height of the house above grade (ft)
- $\boldsymbol{H_0}$ = reference height of one story = 8 ft

The normalized leakage was developed assuming that the volume is 8 ft multiplied by the floor area. Using this assumption, substituting for ELA, and by assuming that the height of one story above grade is 8 ft, the *NL* can be rewritten as:

$$NL = \frac{3.048 * Q_{50}}{V} (stories)^{0.3}$$

Where:

V = volume of the house (ft^3)

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3) Calculation of infiltration at normal operating conditions

$$I = NL * w$$

Where:

w = a weather factor specific to a geographic location

In this equation *I* is in air changes per hour (ACH). The weather factor can be found in a table in ASHRAE Standard 136.

Once the infiltration *I* is determined, it can be converted to CFM using the volume of the house.

$$I_{CFM} = \frac{I * V}{60}$$

Where:

I_{CFM} = infiltration in CFM
60 = conversion from hours to minutes

The infiltration rate at operating conditions, measured in CFM, can then be estimated as

$$I_{CFM} = 0.0508 * w * (stories)^{0.3} * Q_{50}$$

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4) Calculation of ASHRAE Standard 62.2 default infiltration rate

The default infiltration rate I_d from ASHRAE Standard 62.2, measured in CFM, is

$$I_d = 0.02 * A_{floor}$$

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5) Determination of infiltration credit to be credited against required primary ventilation fan flow

If I_{CFM} is greater than I_d, then the infiltration credit I_{cred} can be calculated as

$$I_{cred} = ½(I_{CFM} - I_d)$$

Appendix B: 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.

Appendix C: Guide to 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
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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

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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
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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
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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
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NFPA 70E	Standard for Electrical Safety in the Workplace®	2.0100.1d
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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
2.0104.1b	OSHA	General
2.0105.1b	NIOSH	Recommended Exposure Limit for Carbon Monoxide
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
2.0299.1 (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
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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
2.0601.1c	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
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

3.1002.1b	2012 IRC	N1102.4.1.2
3.1003.5b	2012 IRC	N1102.4.1.2
3.1003.5b	2012 IRC	R402.4.1.2
3.1201.4b	OSHA	General
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
3.1501.1b	2012 IRC	N1103.2.2
3.1501.1f	ANSI/ASHRAE 62.2	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
3.1601.1 (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
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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
3.1602.1 (all)	2012 IRC	Chapter 16
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
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
4.1003.1a	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
4.1006.1a	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
4.1101.1a	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
4.1301.9a	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
5.3003.9j	2012 IRC	N1103.1
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
5.3003.2 (all)	NFPA 31	Standard for the Installation of Oil-Burning Equipment
5.3003.2d	BPI-1100-T-2012	Home Energy Auditing Standard
5.3003.2h	BPI-1100-T-2012	Home Energy Auditing Standard
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

5.3101.1a	ANSI/ACCA J	Residential Load Calculation
5.3101.1b	ANSI/ACCA S	Residential Equipment Selection
5.3101.2a	ANSI/ACCA J	Residential Load Calculation
5.3104.2a	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
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
6.6005.1a	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
6.6102.1c	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
6.6103.1a	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
6.6201.1a	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
6.6202.1c	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
6.6203.1a	ENERGY STAR	General
6.6203.1b	ASHRAE Handbook	Fundamentals
6.6203.1c	2012 IRC	M1401.2
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?
7.8002.1a	ENERGY STAR	General
7.8002.1a	NAECA	National Appliance Energy Conservation Act
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®
7.8004.1a	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
7.8102.1a	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
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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
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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
7.8103.1a	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®

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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
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2.0401.1f	2012 IRC	R405
2.0401.1f	2012 IRC	R406
2.0401.1f	2012 IRC	R703.8
2.0401.2a	2012 IRC	General
2.0401.2a	2012 IRC	R408.2

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2.0401.2a	2012 IRC	R408.2
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