

PA SWS Field Manual



Standard Work Specifications Field Manual for

Single-Family Homes

created by the
Pennsylvania
Weatherization Assistance Program

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FOREWORD

The 2016 Pennsylvania (PA) Standard Work Specifications (SWS) Field Manual which you have before you represents the combined efforts of the PA Weatherization Assistance Program (PA WAP) as well as a national consortium of states and industry professionals to develop a manual that fulfills the needs of those individuals in the field that are required to execute the stringent demands of the SWS as required by the U.S. Department of Energy (DOE).

The hybrid prototype approach produced has been described by DOE as the “Gold Standard” for SWS-compliant field guides.

The SWS contained in this manual define the ‘desired outcomes’ for specific measures and tasks, and is coupled with Pennsylvania’s state-specific guidance regarding policy and technical program requirements. This manual is intended to contain all of the standard work specifications for weatherization measures performed in Pennsylvania. However, all of the national SWS’s (*without state-specific guidance*) are located on the NREL SWS Tool online at <https://sws.nrel.gov/>.

The national Standard Work Specifications and PA’s SWS Field Manual are living documents that will never be finished as long as there is a need for healthier, safer, and more energy efficient housing for Pennsylvanians and the Nation’s citizens.

The PA WAP has the ability to customize this manual to reflect our demographics, regions and needs. The grantee, sub-grantees, and other stakeholders involved in energy conservation for homes in Pennsylvania are encouraged to review, submit, and enhance this work in progress by providing input to PA Department of Community and Economic Development (DCED) or the National Sustainable Structures Center (NSSC) at Pennsylvania College of Technology. A *Proposed Change Form* is provided and should be submitted to wxtechteam@pct.edu.

Training and technical assistance is available to all PA WAP agencies to help their workers and contractors implement the SWS. For questions or assistance regarding Quality Control Inspections, the SWS, and questions of a technical nature, sub-grantees and workers can email wxtechteam@pct.edu.

Policy-related questions and LIHEAP Crisis issues should be referred to PA DCED for a response.

All workers in the field are required to use PA’s SWS Field Manual on the jobsite to reference the desired outcome of specific tasks as well as to ensure the installed measures are 100% compliant with the SWS.

Full adherence to the National DOE SWS began in Pennsylvania on July 1, 2015. All PA WAP sub-grantees and workers will be held accountable to complete measures in accordance with the SWS. DOE and PA WAP Monitors/Quality Control Inspectors will use the SWS to make objective decisions based on a measurable set of outcomes.

THE MAN IN THE ARENA

by Theodore Roosevelt

Excerpt from the speech "Citizenship In A Republic"

Delivered in Paris on 23 April, 1910

It is not the critic who counts; not the man who points out how the strong man stumbles, or where the doer of deeds could have done them better. The credit belongs to the man who is actually in the arena, whose face is marred by dust and sweat and blood; who strives valiantly; who errs, who comes short again and again, because there is no effort without error and shortcoming; but who does actually strive to do the deeds; who knows great enthusiasms, the great devotions; who spends himself in a worthy cause; who at the best knows in the end the triumph of high achievement, and who at the worst, if he fails, at least fails while daring greatly, so that his place shall never be with those cold and timid souls who neither know victory nor defeat.

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(Note: **Referenced Standards** can be found online at https://sws.nrel.gov/referenced_standards.)

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Chapter 1: Guidance on PA WAP Policies & General Procedures

A. Weatherization Process Flowchart

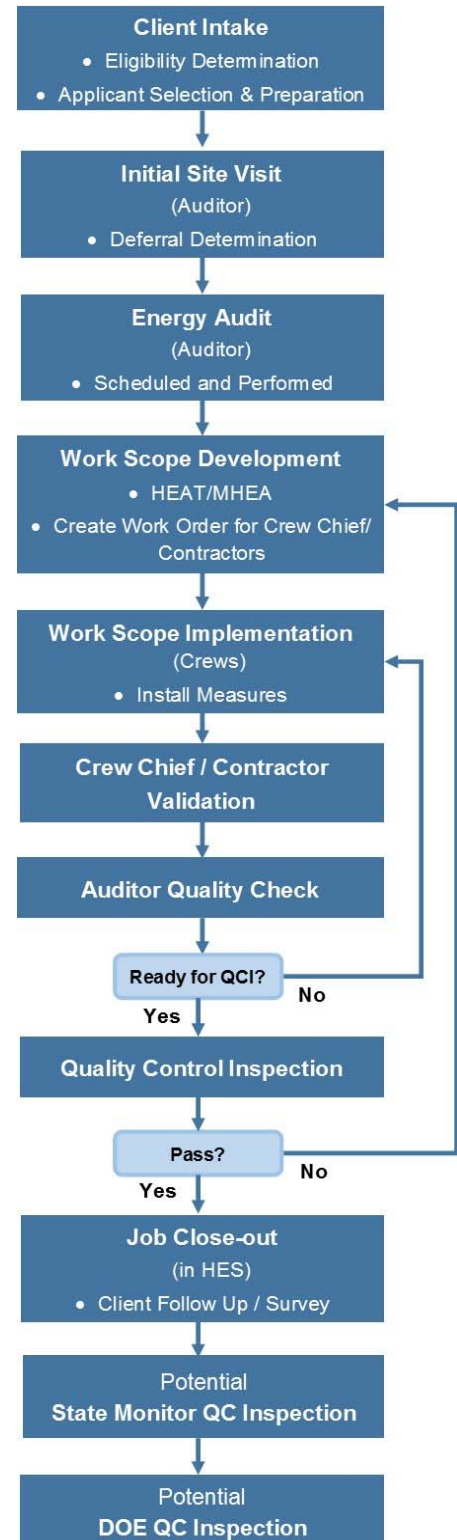
The flowchart on this page and the following descriptions of each step provide a sequence of events that occur in the Weatherization Assistance Program (WAP) process. At each step of the weatherization process, reference the Client File Directive and the Client File Content Checklist to find required information that must be documented.

Client Intake

- Application must be completed and signed
- Ownership of home verified
- Signed release of energy usage information obtained
- Energy usage must be verified
- Eligibility information must be reviewed. Priority ranking established
- If rental, Landlord/Tenant Agreement must be obtained. More details regarding this agreement can be found in the Client File Directive
- Signed permission by homeowner and tenant, if applicable, must be obtained
- Client Proxy information should be reviewed and obtained, if necessary.

Initial Site Visit (can be the same as Energy Audit visit)

- Potential Deferral of Weatherization Services reviewed and copy provided to client
- Appeals Process shared with client
- Complaint Process shared with client
- State Historic Preservation Office (SHPO) documentation and referral completed, if necessary
- Health and Safety forms such as Occupant Health Conditions, Lead Paint Notification, Radon Information, etc. should be reviewed and completed. Please see Health and Safety Directive for all required information.



Energy Audit

- Whole House Standardized Energy Audit conducted and results shared with client
- Health and Safety issues and Energy Conservation techniques reviewed, if not already completed
- Deferral of Weatherization Services form may be completed if unit is to be deferred
- Audit should include all required test results and photos

Work Scope Development

- Scope of work or work order developed
- Scope of work or work order reviewed with and signed by client
- Scope of work or work order sent to and reviewed by agency crew chief and/or subcontractor

Work Scope Implementation

- Measures according to audit are installed
- Changes to the original scope of work must be approved by the client and the agency
- All measures are installed in accordance with the Standard Work Specifications (SWS)

Crew Chief/Subcontractor Validation

- Crew Chief and/or the subcontractor completes a review and safety check at the end of each work day and then at the end of the job to confirm that all measures have been completed according to the SWS

Auditor Quality Check

- Quality analysis to be performed by an auditor (normally the auditor that conducted the initial audit; cannot be the installer, crew chief, or the QCI)
- If call backs are required, client must be made aware of issues
- Client Compact regarding energy conservation measures is reviewed and signed
- Final Client education and warranty information must be provided and documented
- Auditor completes a job quality check to confirm that all measures have been completed according to the SWS and that the job is ready for the upcoming QCI

Quality Control Inspection

- A Quality Control Inspection must be conducted and passed for the unit to be considered complete

Job Close-Out

- All final job costs are compiled and entered into Client File including HES
- All required job paperwork is compiled and added to Client File, required documents and photos are uploaded in HES
- Client follow up and satisfaction survey may be completed at this time. Client must be reminded about potential for a DCED and/or DOE QCI
- Client File Content Checklist (an attachment to the Client File Directive) can be used to review all the required content of the Client File

Potential State Monitor QC Inspection

- Client must be made aware that a Quality Control Inspection may be conducted by a DCED State Monitor

Potential DOE Monitor QC Inspection

- Client must be made aware that a Quality Control Inspection may be conducted by a Department of Energy Monitor

B. General Standards

Materials for Measures

Materials installed using PA WAP funds must meet the standards for conformance based on Appendix A of 10 CFR, part 440 or as approved in the State Audit protocol.

Warranties

Agencies must offer the client warranties in accordance with **SWS 2.0702.1 Warranty and Service Agreement** and **5.3003.7 Occupant Education**. Agency must obtain the client's signoff whether or not they accept and include it in the client file.

Worker Training

Reference DCED Directive: Training Requirements and EPA Lead Safe. Access the most current training directive on DCED's extranet website:

<https://collab.pa.gov/dced/weatherization>.

C. Standardized Energy Audit

Every unit must receive a whole-house standardized energy audit using HEAT (for single-family) or MHEA (for manufactured housing), which are the energy audit software systems that DOE has approved the PA WAP to utilize.

All energy conservation measures must meet the acceptable SIR of 1 or greater for the whole job based on the whole-house standardized audit. Agencies should try to achieve the highest possible SIR for the unit.

Energy Audit Procedure

The BPI ANSI-BPI-1100-T-2014 Home Energy Auditing Standard (see field manual **Appendix A**) should be used as a guide for conducting the whole-house energy audit procedure as it would apply to the Weatherization Assistance Program.

Each energy audit shall include safety and diagnostic testing in accordance with the whole-house standardized audit, and must be documented in the client file. Auditors must perform at least two blower door tests for each unit (one pre-weatherization and one post-weatherization) and document in the client file.

Infrared images are recommended as part of the energy audit.

Photographic Documentation for the Client File

Photos are an integral part of Weatherization Assistance Program projects that help tell the visual story and provide credible backup for. Client files must contain all project photos taken by the Auditor, Crew Chief, Installers, Subcontractors, and Inspectors. The photos should also be included in HES.

Photographic documentation in electronic format is required for all installed measures (beforehand to show the need for a measure, and after installation of a measure). The intent of the photos are to clarify and avoid any future confusion regarding the scope of work and the work actually performed. Additional photo documentation requirements include:

- Lead safe work practices (containment structures with placards and LSWP procedures in progress)
- The crew wearing personal protective equipment when required by OSHA
- When appliances are called to be replaced:
 - photographic documentation depicting the need or reason for replacement
 - the old appliance (including serial number) and the newly installed appliance (including serial number)
- If the work order or standardized audit called for a measure to be installed, but it was not, include any photographic documentation to support why not
- Any concealed or inaccessible areas of the structure that received weatherization measures.

D. Quality Control Inspection Process

Reference DCED Directive: Quality Control Inspection Implementation. Access the most current directive on DCED's extranet website: <https://collab.pa.gov/dced/weatherization>. All units shall have a quality control inspection performed, conducted by a certified Quality Control Inspector. Units can be logged as completed in HES once it has passed a quality control inspection.

QC Inspectors will use the state-approved standardized QCI Check List (see field manual **Appendix B**) to perform the inspection, and will rely on the national SWS to make determinations whether each measure installed has met the desired outcome.

E. Client Education

Client education is a priority and must be provided at a minimum according to the SWS's for each installed measure.

Additional client education guidance is provided in DCED's Client File directive.

Reference DCED Directive: Client File. Access the most current directive on DCED's extranet website: <https://collab.pa.gov/dced/weatherization>

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F. Definitions of commonly used SWS terms in PA WAP

Check SWS Tool website to find the most up-date definitions for these and many more SWS terms: <https://sws.nrel.gov/lexicon/5#>.

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

ASHRAE: American Society of Heating, Refrigerating and Air-Conditioning Engineers

Boot: A duct section that connects between a duct and a register or between round and square ducts

BTU: British thermal unit

CAZ: Combustion appliance zone

CFM: Cubic feet per minute

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

Confined Space: A space that: (1) Is large enough and so configured that an employee can bodily enter it; (2) Has limited or restricted means for entry and exit; and (3) Is not designed for continuous employee occupancy.

Dense pack: The process of installing loose-fill insulation to reduce air flow and perform to a stated R-value

Eaves: The edges of a roof system (See: Soffit)

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

Envelope: The separation between the interior and exterior environments of a building that includes a combination of air and thermal barrier

Exfiltration: The uncontrolled passage of inside air out of a building through unintended leaks in the building envelope

Flashing: Waterproof material used to prevent leakage at intersections between the roof surface at walls or penetrations

Floor Joists: The framing members that support the floor area

Flue: The framing members that support the floor area

Glazing: Glass installation. Pertaining to glass assemblies or windows

IAQ: Indoor Air Quality

IECC: International Energy Conservation Code

Infiltration: The uncontrolled passage of outside air into a building through unintended leaks in the building envelope

IRC: International Residential Code

Jamb: The side or top piece of a window or door frame

Joist: A horizontal wood framing member that supports a floor or ceiling

Low-E: Short for “low emissivity”, which means the characteristic of a metallic glass coating to resist the flow of radiant heat

Make-up Air: Air supplied to a space to replace exhausted air

Manufactured Home Energy Audit (MHEA): A software tool that predicts manufactured home energy consumption and recommends weatherization retrofit measures

Permit-required Confined Space (permit space): A confined space that has one or more of the following characteristics: (1) Contains or has a potential to contain a hazardous atmosphere; (2) Contains a material that has the potential for engulfing an entrant; (3) Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor which slopes downward and tapers to a smaller cross-section; or (4) Contains any other recognized serious safety or health hazard.

Plate: A piece of lumber installed horizontally to which the vertical studs in a wall frame are attached

Plenum: The piece of ductwork, usually found above the heat exchanger of a hot air furnace, that connects the air handler to the main supply duct

PPE: Personal protective equipment

R-Value: A measurement of thermal resistance for materials and related surfaces

Register: The grille cover over a duct outlet for warm air distribution or cold air return

Relamping: The replacement of an existing, standard light bulbs with lower wattage energy efficient bulbs like compact fluorescent lamps

Rim Joist: The outermost joist around the perimeter of the floor framing

Savings-to-Investment Ratio (SIR): They are computed over the lifetimes of the retrofit measures installed and expressed in terms of the net present value of the retail cost of the dwelling's fuel. Under some methodologies, other benefits, etc. Investment usually takes into account materials, labor, and support costs. SIRs of greater than one are counted as cost effective under this DOE WAP method of determining cost-effectiveness

Sill: The bottom of a window or door frame

Soffit: The underside of a roof overhang or a small lowered ceiling, as above cabinets or a bathtub

Spillage: Temporary flow of combustion gases from a dilution device

Stop: A thin, trim board for windows and doors to close against or slide against

Strike Plate: The metal plate attached to the door jamb that the latch inserts into upon closing

Thermal boundary: The separation between the interior and exterior environments of a building that slows heat flow

Truss: A lightweight, rigid framework designed to be stronger than a solid beam of the same weight

U-Value: The amount of heat flowing through a square foot of building materials

Unconditioned basement: A below- or partially below-grade livable space with concrete or finished floor without intentional heating or cooling

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

Chapter 2: Health & Safety

WAP is primarily an energy efficiency program; however, what we do affects the health and safety of the structure and the occupants. When considering what activities make sense as a health and safety expense, consider these two questions:

- What must we do within reasonable costs to get the home to a point where we can go forward with weatherizing, where the weatherization work will be lasting and effective?
- What must we do to ensure that the weatherization work we conducted does not create a health or safety problem for the occupant?

Important Considerations for Health and Safety:

- **SWS 2.0201.1i: At the conclusion of each work day in which envelope or duct sealing measures have been performed, depressurization and spillage testing will be performed.**
- Agencies must adhere to applicable federal, state, and local codes and mandates.

PA Health & Safety Plan

Reference DCED Directive: Health and Safety. Access the most current directive on DCED's extranet website: <https://collab.pa.gov/dced/weatherization>.

Agencies must adhere to the DOE-approved **PA WAP Health & Safety Plan**, which provides rules and guidance on budgeting considerations, expenditure limit, health and safety topics areas, incidental repairs, and deferrals.

Agencies must ensure their staff and relevant workers have reviewed and understand the PA WAP Health and Safety Plan.

Health & Safety Topic Areas

Replacements: <ul style="list-style-type: none"> • Heating systems • Appliances and water heaters • Refrigerant • Window and door replacements, window guards 	Mold & Moisture <ul style="list-style-type: none"> • Mold and Moisture • Drainage – gutters, down spouts, extensions, flashing, sump pumps, landscape, etc.
Asbestos <ul style="list-style-type: none"> • In siding, walls, ceilings, etc. • In vermiculite • On pipes, furnaces, and other small covered surfaces 	Combustion Appliance Safety and Heating Systems <ul style="list-style-type: none"> • Combustion Gases • Solid Fuel Heating – wood stoves, etc. • Stand Alone Electric Space Heaters • Unvented Combustion Space Heaters • Vented Combustion Space Heaters • Smoke/Carbon Monoxide Alarms & Fire Extinguishers
Codes & Structure <ul style="list-style-type: none"> • Building structure and roofing • Code compliance • Fire hazards • Electrical, other than Knob-and-tube wiring • Knob-and-tube wiring 	Occupant Wellness <ul style="list-style-type: none"> • Occupant Preexisting or Potential Health Conditions • Biologicals and Unsanitary Conditions – odors, mustiness, bacteria, viruses, raw sewage, rotting wood, etc. • Pests • Formaldehyde, Volatile Organic Compounds (VOC), and other Air Pollutants • Injury Prevention
OSHA for WAP <ul style="list-style-type: none"> • OSHA and Crew Safety • Spray Polyurethane Foam (SPF) 	Radon
Lead-based Paint	ASHRAE 62.2 for WAP

Deferrals

The decision to defer work in a dwelling is difficult but necessary in some cases. This does not mean that assistance will never be available, but that work must be postponed until the problems can be resolved or alternative sources of help are found. If in the judgment of the auditor, any conditions exist that may endanger the health or safety of the workers or occupants, and these conditions cannot be corrected with health and safety funds, the unit should be deferred until the conditions are corrected. Deferral may also be necessary where occupants are uncooperative, abusive, or threatening.

However, Agencies must do everything in their power (without expending DOE funds unless weatherization is being conducted) to ensure that clients and their families are separated from life-threatening situations: whether by removing or repairing the dangerous component, referring the situation to some other entity for help, persuading the client to leave the home or any other possible remedy, clients and their families must be separated from the situation. Additionally, if a health and safety situation arises that the Agency cannot remedy because it may go over its health and safety expenditure limit, then the Agency may request that the client spend his/her own private funds on the health and safety issue in order for the Agency to complete weatherization services at the home.

DCED Health and Safety Directive provides two deferral forms: (1) *Notification of Potential Health and Safety Issues Deferral of Weatherization Services* and (2) *Health and Safety Deferral of Weatherization Services*. The first form contains a list of potential reasons for deferring a home, and the second form is one which can be used when actually deferring the home. DCED's Health and Safety Directive also provides a sample *Client Appeals Process* template for the Agency to customize. Client must sign and date the *Notification of Potential Health and Safety Issues Deferral of Weatherization Services* form and the *Client Appeals Process* form, generally at the time of application for the program.

If a unit's H&S measures go over the agency's per-unit average, WAP agencies **may** defer the home while referring it to a different program capable of remedying the H&S issues, after which it may weatherize the home.

If deferred, clients must receive notification that includes:

- Reasons for deferral
- How the client's home may become eligible
- Actions the client should take in order for the home to no longer be deferred

The client file must contain **written and photographic documentation** of how it meets deferral qualifications. A copy of the notification indicating it has been sent to the client must also be included in the client file.

Crosswalk of Health & Safety SWS with the ANSI/BPI 1100 Energy Auditing Standard

The SWS for Health and Safety will apply to Auditors as they follow the ANSI-BPI-1100-T-2014 Home Energy Auditing Standard sections 3, 7, 8, 9, 10, 11, 12, and 13.

2. Health & Safety SWS

Topic 2.01 Safe Work Practices

Subtopic 2.0100 Safe Work Practices

2.0100.1 Global Worker Safety

Topic: Safe Work Practices

Subtopic: Safe Work Practices

Desired Outcome: Work completed safely without injury or hazardous exposure

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

For supporting material, see [Referenced Standards](#).

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

Title	Specification(s)	Objective(s)
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2.0100.1b
Hand protection



Unsafe

Recognize potential risks



Safe

Wear appropriate hand protection



GOOD: Wear nitrile gloves when handling mastic.



Inspect gloves for holes and damage to minimize risk.

Title	Specification(s)	Objective(s)
2.0100.1c Respiratory protection	<p>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)</p> <p>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</p> <p>When applying high-pressure <i>SPF</i> insulation, supplied air respirators (SARs) will be used</p> <p>Consult MSDSs for respiratory protection requirements</p>	Minimize exposure to airborne contaminants (e.g., insulation materials, mold spores, feces, bacteria, chemicals)



Unsafe

Workers need to properly protect their airways when retrofitting



Best Practice

Retrofits can have multiple different respiratory protection requirements



Whenever airborne contaminants are a possibility, wear an N-95 mask



For two-component spray insulation, P-100 respirators should be used



All P-100s should be fitted to the individual worker

When working with high-pressure spray foam, use a Supplied Air Respirator



When unsure what level of protection necessary, check the SDS

Title	Specification(s)	Objective(s)
2.0100.1d Electrical safety	<p>An electrical safety assessment will be performed</p> <p>All electric tools will be protected by ground-fault circuit interrupters (<i>GFCI</i>)</p> <p>Three-wire type extension cords will be used with portable electric tools</p> <p>Worn or frayed electrical cords will not be used</p> <p>Water sources (e.g., condensate pans) and electrical sources will be kept separate</p> <p>Metal ladders will be avoided</p> <p>Special precautions will be taken if knob and tube wiring is present</p> <p>Aluminum foil products will be kept away from live wires</p> <p>For arc flash hazards, <i>NFPA</i> 70E will be consulted</p>	<p>Avoid electrical shock and arc flash hazards</p>



Unsafe

Inspect house for unsafe electrical situations



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

Title	Specification(s)	Objective(s)
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2.0100.1d

Electrical safety



Use GFCIs and three-wire extension cords for all power tools



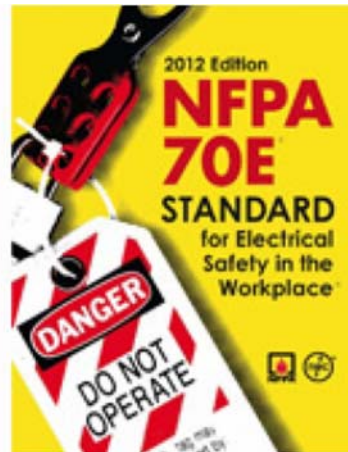
Electrical wiring should not be located near a water source



Fiberglass ladders are recommended. Metal ladders conduct electricity and should never be used near energized electric wires.



Recognize if knob and tube wiring is present and take special precautions



Follow NFPA 70E 2012 guidelines for arc flash hazards

Title	Specification(s)	Objective(s)
2.0100.1e Carbon monoxide (CO)	<p>All homes will have a carbon monoxide alarm</p> <p>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)</p>	Protect worker and occupant health



Unsafe

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

Tools:

1. CO meter



Best Practice

Install carbon monoxide alarms

2.0100.1f Protective clothing	<p>MSDSs and OSHA regulations will be consulted for protective clothing and equipment</p> <p>Eye protection will always be worn (e.g., safety glasses, goggles if not using full-face respirator)</p>	<p>Protect worker from skin contact with contaminants</p> <p>Minimize spread of contaminants</p>
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Before

Workers should be aware of work required and dress appropriately



After

Ensure workers have proper protective equipment for work environment

Title	Specification(s)	Objective(s)
2.0100.1g Confined space safety	<p>Access and egress points will be located before beginning work</p> <p>Inspection will be conducted for frayed electrical wires</p> <p>Adequate ventilation will be provided</p> <p>Use of toxic material will be reduced</p>	<p>Prevent build-up of toxic or flammable contaminants</p> <p>Provide adequate access and egress points</p> <p>Prevent electrical shock</p>
PA WAP Guidance:	See PA WAP Health and Safety Plan. Confined space requires a competent person. If there is a permit-required confined space, the unit may be deferred if it is cost-prohibitive.	



After

Locate all access and egress points of confined spaces before entering



Perform visual inspection of confined spaces before beginning work



Check for frayed or worn wires



In confined spaces, use a ventilator



Check GHS labels and Safety Data Sheets for all materials to minimize hazards

Title	Specification(s)	Objective(s)
2.0100.1h Power tool safety	<p>Power tools will be inspected and used in accordance with manufacturer specifications and OSHA regulations to eliminate hazards such as those associated with missing ground prongs, ungrounded circuits, misuse of power tools, noise, and improper or defective cords or extension cords</p> <p>All devices used will be verified as GFCI protected or double insulated</p> <p>Exhaust gases from compressors and generators will be prevented from entering interior space</p>	Prevent power tool injuries
2.0100.1i Chemical safety	<p>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</p> <p>Appropriate personal protective equipment (PPE) will be provided</p> <p>Workers will be trained on how to use PPE</p> <p>Workers will be expected to always use appropriate PPE during work</p>	Prevent worker exposure to toxic substances
2.0100.1j Ergonomic safety	<p>Appropriate PPE will be used (e.g., knee pads, bump caps, additional padding)</p> <p>Proper equipment will be used for work</p> <p>Proper lifting techniques will be used</p>	Prevent injuries from awkward postures, repetitive motions, and improper lifting



Unsafe

Workers will take precautions to protect themselves on the job site



Best Practice

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

Title	Specification(s)	Objective(s)
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	<p>Caution will be used around power cords, hoses, tarps, and plastic sheeting</p> <p>Precautions will be taken when ladders are used, when working at heights, or when balancing on joists</p> <p>Walk boards will be used when practical</p> <p>Appropriate footwear and clothing will be worn</p>	Prevent injuries due to slips, trips, and falls
2.0100.1m Heat and thermal stress	<p>Appropriate ventilation, hydration, rest breaks, and cooling equipment will be provided</p> <p>911 will be dialed when necessary</p>	Prevent heat stroke, heat stress, and cold stress related injuries



Attics and crawl spaces can be dangerous work places in the heat



Keep workers comfortable with hydration and cool vests

2.0100.1n Fire safety	<p>Ignition sources will be identified and eliminated (e.g., turn off pilot lights and fuel supply)</p> <p>Use of flammable material will be reduced and fire-rated materials will be used</p>	Prevent a fire hazard
2.0100.1o Asbestos-containing materials (ACM)	<p>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</p> <p>If suspected ACM is in good condition, do not disturb</p> <p>If suspected ACM is damaged (e.g., unraveling, frayed, breaking apart), immediately isolate the area(s)</p> <p>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</p>	Protect workers and occupants from potential asbestos hazards

Title	Specification(s)	Objective(s)
	<p>federal, state, and local requirements; only a licensed or trained professional may abate, repair, or remove ACM</p> <p>When working around ACM , do not:</p> <ul style="list-style-type: none"> • Dust, sweep, or vacuum ACM debris • Saw, sand, scrape, or drill holes in the material • Use abrasive pads or brushes to strip materials <p>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</p>	
PA WAP Guidance:	Refer to PA WAP Health and Safety Plan.	
2.0100.1p Lead paint assessment	<p>Presence of lead based paint in pre-1978 homes will be assumed unless testing confirms otherwise</p> <p>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</p>	Protect workers and occupants from potential lead hazards
PA WAP Guidance:	<p>Refer to PA WAP Health and Safety Plan.</p> <p>Remember to document lead-safe work practices in the Client File (photos).</p>	

Subtopic 2.0103 Air Sealing

2.0103.1 Air Sealing Worker Safety

Topic: Safe Work Practices

Subtopic: Air Sealing

Desired Outcome: Work completed safely without injury or hazardous exposure

Title	Specification(s)	Objective(s)
2.0103.1a Worker safety	All worker safety specifications in Global Worker Safety section will be followed	<p>Prevent injury</p> <p>Minimize exposure to health and safety hazards</p>

Subtopic 2.0104 Insulation

2.0104.1 Insulation Worker Safety

Topic: Safe Work Practices

Subtopic: Insulation

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

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

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	<p>OSHA asbestos abatement protocol 29 CFR 1926.1101 will be followed if vermiculite insulation is present</p> <p>If unsure whether material contains asbestos, a qualified asbestos professional will be contacted to assess the material and to sample and test as needed</p> <p>When working around asbestos-containing material (ACM), the following will not be done:</p> <ul style="list-style-type: none">• Dust, sweep, or vacuum debris• Saw, sand, scrape, or drill holes in the material• Use abrasive pads or brushes to strip materials <p>Attic insulation that looks like vermiculite (as opposed to fiberglass, cellulose, or urethane foams) will not be removed or disturbed</p>	Protect workers from toxic exposure
PA WAP Guidance:	Refer to PA WAP Health and Safety Plan. When vermiculite insulation is discovered, precautions must be taken, and it may not be removed.	



Unsafe

If material is identified as vermiculite,



DO NOT DISTURB VERMICULITE!

Title	Specification(s)	Objective(s)
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	<p>Presence of lead based paint in pre-1978 homes will be assumed unless testing confirms otherwise</p> <p>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</p>	Protect worker and occupant from potential lead hazards
PA WAP Guidance:	<p>Refer to PA WAP Health and Safety Plan.</p> <p>Remember to document lead-safe work practices in the Client File (photos).</p>	

Subtopic 2.0105 Heating and Cooling Equipment

2.0105.1 Combustion Worker Safety

Topic: Safe Work Practices

Subtopic: Heating and Cooling Equipment

Desired Outcome: Work completed safely without injury or hazardous exposure

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

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

Tools:

1. CO meter



Before

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



After

Install carbon monoxide alarm if none are found

Title	Specification(s)	Objective(s)
2.0105.1c Raw fuel	<p>Raw fuel leaks will be monitored for before entering building spaces</p> <p>If leaks are found, testing will be discontinued and condition reported to occupant immediately</p>	Protect worker and occupant health



Before

Fuel leaks need to be repaired by appropriate professional

Tools:

1. Gas sniffer
2. Bubble solution



After

Notify occupant of any leaks



Check all raw fuel lines for leaks. Use multiple methods to test for leakage--bubble solution



If bubbles develop, leak is present. Notify the occupant and stop work.



2.0105.2 Heating and Cooling Worker Safety

Topic: Safe Work Practices

Subtopic: Heating and Cooling Equipment

Desired Outcome: Work completed safely without injury or hazardous exposure

Title	Specification(s)	Objective(s)
2.0105.2a 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	When replacing existing thermostats, identify and dispose of any mercury containing thermostats in accordance with Environmental Protection Agency (EPA) guidance	Protect workers and occupants from mercury exposure



Unsafe

Mercury thermostats should be replaced and disposed of properly



Unsafe

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

Paraphrased from 40 CFR 273.14: A universal waste mercury-containing thermostat or container containing only universal waste mercury-containing thermostats should be labeled or marked clearly with any of the following phrases: "Universal Waste-Mercury Thermostat(s)," "Waste Mercury Thermostat(s)," or "Used Mercury Thermostat(s)."

**Contact thermostat-recycle.org or earth911.org for recycling options.

Title	Specification(s)	Objective(s)
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
PA WAP Guidance:	Refer to PA WAP Health and Safety Plan.	



Suspicious pipe insulation may contain asbestos

Unsafe

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
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Unsafe

When working with refrigerants, short sleeves are inappropriate



Safe

When working with refrigerants, workers should dress appropriately

Subtopic 2.0106 Ventilation Equipment

2.0106.1 Ventilation Worker Safety

Topic: Safe Work Practices

Subtopic: Ventilation Equipment

Desired Outcome: Work completed safely without injury or hazardous exposure

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

Subtopic 2.0107 Baseload

2.0107.1 Baseload Worker Safety

Topic: Safe Work Practices

Subtopic: Baseload

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

Title	Specification(s)	Objective(s)
2.0107.1a Worker safety	All worker safety specifications in Global Worker Safety section will be followed	Prevent injury Minimize exposure to health and safety hazards

Subtopic 2.0110 Material Safety

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

Topic: Safe Work Practices

Subtopic: Material Safety

Desired Outcome: Occupant and worker risk from hazardous materials minimized

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

Subtopic 2.0111 Basements and Crawl Spaces

2.0111.1 Basements and Crawl Spaces Worker Safety

Topic: Safe Work Practices

Subtopic: Basements and Crawl Spaces

Desired Outcome: Work completed safely without injury or hazardous exposure

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

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

Title	Specification(s)	Objective(s)
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2.0111.1a

Worker safety



Unsafe

Fuel leaks need to be repaired



Safe

Repairs need to be tested and verified to no longer leak

Tools:

1. Gas sniffer
2. Bubble solution

Paraphrased from 2012 IRC G2417: Leakage will be located using an approved combustible gas detector, a noncorrosive leak detection fluid or an equivalent nonflammable solution. Matches, candles, open flames or other methods that could provide a source of ignition cannot be used. Where leakage or other defects are located, the affected portion of the piping system will be repaired or replaced and retested.

Measures

Measure 12 Repair - Gas Leak in Crawlspace (flagged)

Comment

#	Material / Labor	Description /Comment	Units
10	Unspecified	Misc Material	Each



1. Fuel leaks discovered during initial audit should be flagged

2. Use approved combustion gas sniffer to see if repaired line still leaks



3. Confirm repair and remove flag

2.0111.2 Crawl Spaces—Pre-Work Qualifications

Topic: Safe Work Practices

Subtopic: Basements and Crawl Spaces

Desired Outcome: Site properly prepared for upgrade

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
PA WAP Guidance:	<p>Refer to PA Health & Safety Plan. Mold testing and/or removal is not allowable. If mold is present, educate client. Repair of limited water damage may only be conducted when necessary for the effective performance or preservation of weatherization materials, and will only be funded as a cost justified incidental repair (achieves SIR of 1 or greater). Where mold and moisture issues cannot be addressed, deferral is required.</p> <p>Visual assessment is required and diagnostics such as moisture meters are recommended to measure and record moisture levels at pre-weatherization and post weatherization. Air sealing diagnostic of building envelope is required on final inspection.</p>	
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
PA WAP Guidance:	Refer to PA Health & Safety Plan. These are considered incidental repairs and should be installed only when necessary for the effective performance or preservation of a weatherization measure.	
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
PA WAP Guidance:	Refer to PA Health & Safety Plan. Limited funds available when infestation would prevent weatherization. Unit may be deferred if infestation cannot be remediated and/or poses a health and safety concern for workers.	
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
PA WAP Guidance:	Refer to PA Health & Safety Plan. Building rehabilitation is beyond the scope of the Weatherization Assistance Program. Homes with conditions that require more than incidental repairs should be deferred.	

Title	Specification(s)	Objective(s)
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 <i>HVAC</i> system work has been completed and inspected	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
PA WAP Guidance:	Refer to PA Health & Safety Plan. In most cases standing water will be cause for deferral. If adding a sump pump, verify beforehand with your state monitor.	
2.0111.2i Non-correctable standing water	Spaces with non-correctable standing water will not be considered for a <i>closed crawl space</i>	Prevent possible damage to house
PA WAP Guidance:	Refer to PA Health & Safety Plan. Homes will be deferred when the moisture problems cannot be resolved under existing incidental repair cost rules of an overall SIR of 1 or greater which must be achieved.	

2.0111.3 Crawl Spaces—Debris Removal

Topic: Safe Work Practices

Subtopic: Basements and Crawl Spaces

Desired Outcome: Clean, safe, and easily accessible crawl space created

For supporting material, see [Calculation of the Infiltration Credit](#) and [Referenced Standards](#).

Title	Specification(s)	Objective(s)
2.0111.3a Debris removal	<p>Under-floor grade will be removed of all vegetation and organic material</p> <p>Debris that can cause injury or puncture ground covers (e.g., nails, glass, sheet metal screws, etc.) will be removed from the crawl space</p>	<p>Minimize punctures in ground liner</p> <p>Minimize habitat for pests (Integrated Pest Management—IPM) and contaminant sources</p>



Before

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



After

Rake up and clear away trash and overgrowth.

Tools:

1. Rake
2. Shop vacuum
3. PPE

2.0111.3b Debris disposal	Debris will be properly disposed of according to type and jurisdiction	Protect environment from damage
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2.0111.4 Negative Pressure Contamination Control

Topic: Safe Work Practices

Subtopic: Basements and Crawl Spaces

Desired Outcome: Contaminants prevented from entering house during work process

Title	Specification(s)	Objective(s)
2.0111.4c Pressure	A negative pressure will be maintained in the crawl space with reference to the house while work is being performed in the crawl space	Prevent contaminants from entering house
PA WAP Guidance:	Ventilate the crawl space while performing work. This will also be required to comply with the OSHA Confined Space standard.	

Topic 2.02 Combustion Safety

Subtopic 2.0201 Combustion Safety Testing-General

2.0201.1 Combustion Appliance Zone (CAZ) Testing

Topic: Combustion Safety

Subtopic: Combustion Safety Testing-General

Desired Outcome: Accurate information about appliance safe operation is gathered

For supporting material, see [Calculation of the Infiltration Credit](#) and [Referenced Standards](#).

Title	Specification(s)	Objective(s)
2.0201.1a Assessment	<p>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</p> <p>Determine if combustion and dilution air is adequate for proper combustion and venting of all equipment within the CAZ</p> <p>Examine appliance for signs of damage, misuse, improper repairs, and lack of maintenance</p>	<p>Ensure system does not have fatal problems</p> <p>Ensure combustion appliance has adequate combustion and dilution air</p>



Before

Unsafe combustion appliances indicate need for repair or replacement



After

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

Title	Specification(s)	Objective(s)
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2.0201.1a Assessment



Assess existing combustion appliances for damage and replace when necessary



Stop the misuse of combustion appliances -- camp heater in bedroom



Ensure there is adequate make-up air -- combustion air inlet in closet



Keep occupant apprised of any health or safety concerns

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



Before

Fuel lines should be inspected for leakage

Tools:

1. Gas sniffer
2. Spray bottle



After

If leaks are found, notify occupant immediately to facilitate repair

Materials:

1. Bubble solution



Inspect exterior gas and oil lines for leaks and damage



Inspect flex lines for damage, and check date on ring for pre-1973 hardware

Title	Specification(s)	Objective(s)
2.0201.1c Venting	Combustion venting systems will be inspected for damage, leaks, disconnections, inadequate slope, and other safety hazards	Determine if a <i>draft regulator</i> is present and working and if vent system is in good condition and installed properly
PA WAP Guidance:	Not all systems require a draft regulator.	



Unsafe

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



Safe

Properly vented appliances make a house healthier and more efficient



Determine if a draft regulator is installed and working



Inspect vent connector for damage



Inspect for disconnected pipes



Inspect for inadequate slope



Inspect for missing draft diverter

Title	Specification(s)	Objective(s)
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



Best Practice

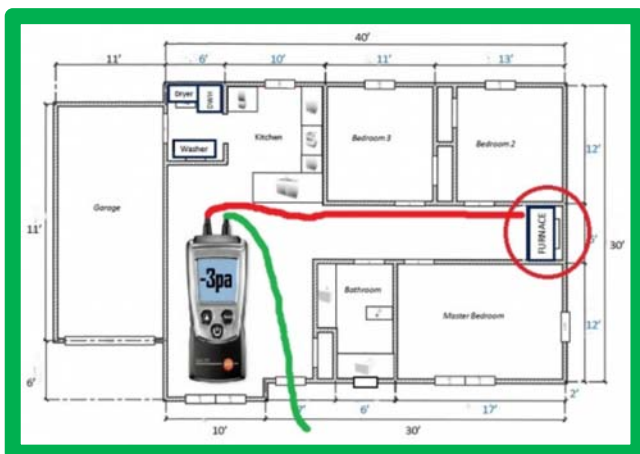
Natural conditions--Winter set-up,
Exhaust fans off, Interior doors open

Tools:

1. Manometer

If using a DG700, you may use the baseline feature on Channel A for this test.

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
PA WAP Guidance:	Always apply the manufacturer's certified negative pressure tolerance first. If not available, use SWS Section 2.0299.1 table, under Additional Resources.	



Best Practice

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

Tools:

1. Manometer

Title	Specification(s)	Objective(s)
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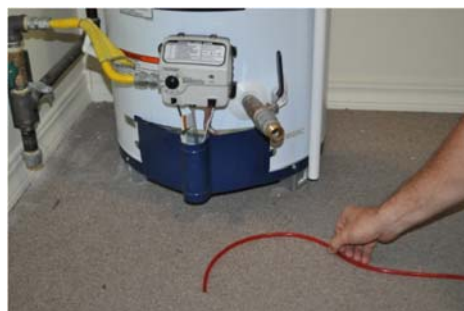
2.0201.1e – Depressurization test



1. Place manometer reference hose to exterior of house



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



3. Place test hose by combustion appliance



4. Take baseline reading



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



6. Is the air handler on?



7. Check interior doors for pressure differential either using smoke pencil or hand



8. If reading is within allowable limit, all is well

Title	Specification(s)	Objective(s)
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
PA WAP Guidance:	If there is spillage after 2 minutes, check the chimney for blockage and do the confined space calculation.	



Tools:

1. Smoke pencil
2. Timer



Best Practice

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

Unsafe

Test natural draft furnace or water heater for spillage in excess of 2 min

2.0201.1g Carbon monoxide (CO) test in appliance vent	<p>CO will be tested for in undiluted flue gases of combustion appliances</p> <p>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)</p> <p>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)</p>	Measure CO and report excessive levels
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Unsafe

CO levels cannot exceed 200ppm as measured, unless to manufacturer specs



Best Practice

Test CO levels in undiluted flue gases

Tools:

1. Combustion analyzer with probe

Title	Specification(s)	Objective(s)
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2.0201.1g – Carbon monoxide (CO) test in appliance vent



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



Test undiluted flue gases in induced draft furnaces



Test undiluted flue gases in natural draft furnaces



Test undiluted flue gases in natural draft water heaters



Test accessible exhaust outlets for direct-vent appliances



Test accessible exhaust outlets for power-vented appliances

Title	Specification(s)	Objective(s)
2.0201.1i Combustion safety testing at completion of retrofitting home	At the conclusion of each work day in which <i>envelope</i> or duct sealing measures have been performed, depressurization and spillage testing will be performed	Ensure work completed in home has not adversely affected the operation of combustion appliances

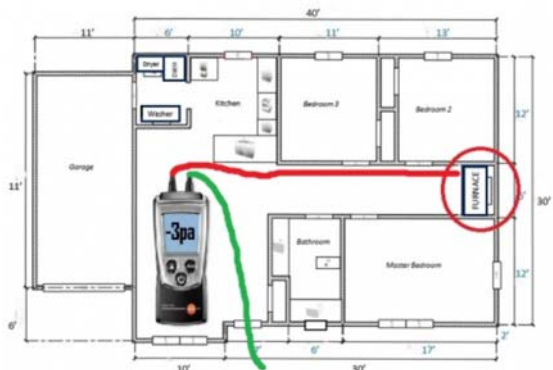


Conduct spillage and depressurization testing at the end of the work day

Tools:

1. Manometer
2. Smoke pencil
3. Timer

Unsafe



Run depressurization test at the end of the work day



Complete spillage test using chemical smoke pencil



Test for spillage on all sides of draft diverter



Complete spillage testing on all combustion appliances



Complete carbon monoxide testing using a CO detector

2.0201.2 Combustion Safety

Topic: Combustion Safety

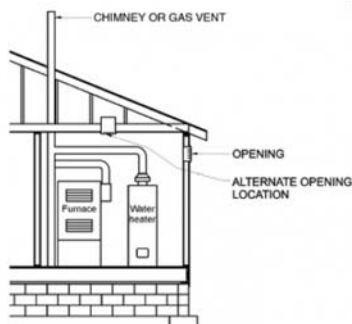
Subtopic: Combustion Safety Testing-General

Desired Outcome: Buildup of dangerous combustion byproducts in the living space prevented

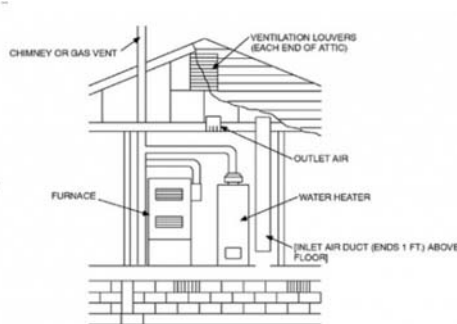
Note: The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.

For supporting material, see [Calculation of the Infiltration Credit](#) and [Referenced Standards](#).

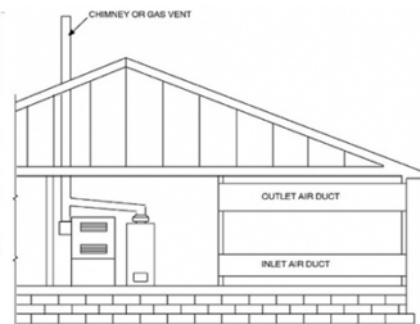
Title	Specification(s)	Objective(s)
2.0201.2a Outside combustion make- up air	Where applicable, combustion air will be provided from the outside and installed in accordance with the 2012 <i>IRC</i> for the type of appliance installed	Prevent combustion byproducts from entering the house



min free area of 1 sq in
per 3,000 Btu/h
(734 mm²/kW) of total
input rating



min free area of 1 sq in
per 4,000 Btu/h
(550 mm²/kW) of total
input rating



min free area of 1 sq in
per 2,000 Btu/h
(1100 mm²/kW) of total
input rating

Title	Specification(s)	Objective(s)
2.0201.2b New appliances	New 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
PA WAP Guidance:	When replacing furnaces, a 90+ AFUE unit should be installed if possible	



Before

Damaged combustion appliances beyond repair should be replaced



After

Sealed-combustion power-vented or sealed-combustion direct-vent appliances should replace unsafe appliances



Two-pipe 90% efficiency furnaces are viable replacement appliances



Direct vent combustion appliances are also viable replacements

Title	Specification(s)	Objective(s)
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

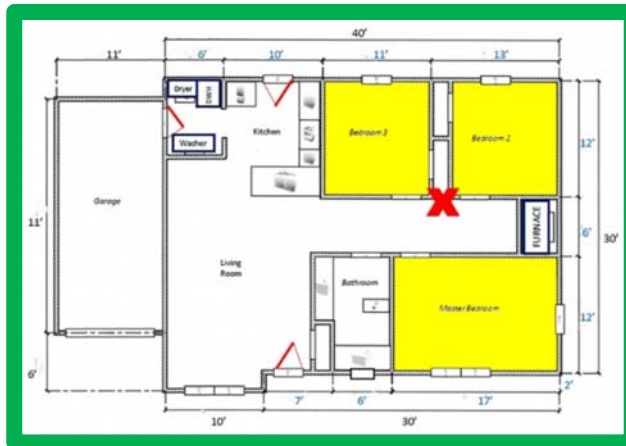


Best Practice

Carbon Monoxide alarms should be installed according to local codes

Tools:

1. Drill



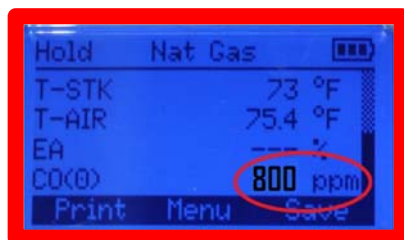
Best Practice

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

Materials:

1. CO alarm
2. Fasteners

2.0201.2d Gas ovens	Gas ovens will be tested for CO A clean and tune will be conducted if measured CO in the undiluted flue gases of the oven vent at steady state exceeds 200 ppm or 800 ppm by air-free measurement	Ensure clean burn of gas ovens
PA WAP Guidance:	Replacement of gas ranges is not allowable with DOE funds. Provide client education.	



Unsafe

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

Tools:

1. Combustion analyzer with probe



Best Practice

Test gas oven for carbon monoxide using a combustion gas analyzer

Title	Specification(s)	Objective(s)
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
PA WAP Guidance:	Replacement of gas ranges is not allowable with DOE funds. Provide client education.	



Before

Discoloration (yellow, uncontrolled flames) indicate the need for a clean and tune



Gas ranges should be cleaned and tuned if improper operation is evident



After

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

2.0201.2f Solid fuel burning appliances	If the solid fuel burning appliance is the primary heat source and has signs of structural failure replace solid fuel burning appliance with UL -listed and EPA -certified appliances if the existing appliance is not UL -listed	Ensure safe operations of solid fuel burning appliances
PA WAP Guidance:	Consult your state monitor before replacing.	



Unsafe

Unsafe solid fuel burning



Safe

New appliances should be UL-listed and EPA-certified

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



Locate data plate to find out appliance ratings

Check appliance rating plates for EPA and UL markings (or CSA, ETL, or WH markings)



Subtopic 2.0202 Unvented Space Heaters

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

Topic: Combustion Safety

Subtopic: Unvented Space Heaters

Desired Outcome: Elimination of combustion byproducts

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

PA WAP Guidance: 2.0202.1 Unvented Space Heaters	<p>Testing for air-free carbon monoxide (CO) is required. Check units for ANSI Z21.11.2 label.</p> <p>Removal is required, except as a secondary heating source when the unit conforms to ANSI Z21.11.2 or as a primary heating source until a replacement heating system is in place.</p> <p>The homes of clients who refuse to allow removal any primary unvented combustion space heater which does not meet ANSI Z21.11.2 standards will be deferred until the unvented combustion space heater is removed.</p> <p>Inform clients of the dangers of unvented space heaters – CO, moisture, and NO2. CO can be dangerous even if CO alarm does not sound.</p>
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Title	Specification(s)	Objective(s)
2.0202.1a Removal	<p>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</p> <p>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</p> <p>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</p>	<p>Eliminate sources of combustion byproduct within a living space</p>
2.0202.1b Occupant education	<p>Occupant will be educated on potential hazards of unvented combustion appliances (primary or secondary) within a living space</p>	<p>Inform occupant about possible hazards associated with combustion byproducts and moisture</p>

Subtopic 2.0203 Vented Gas Appliances

2.0203.1 Combustion Air for Natural Draft Appliances

Topic: Combustion Safety

Subtopic: Vented Gas Appliances

Desired Outcome: Sufficient air provided in the Combustion Appliance Zone ([CAZ](#))

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

Title	Specification(s)	Objective(s)
2.0203.1a Required combustion air	The required volume of indoor air will be determined in accordance with 2012 IRC Section G2407.5.1 or G2407.5.2 and authority having jurisdiction, except that where the air infiltration rate is known to be less than 0.40 air changes per hour (ACH), 2012 IRC Section G2407.5.2 will be used	Determine if existing conditions meet the combustion air calculation
PA WAP Guidance:	Also often referred to as the confined space 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

Desired Outcome: Flue gasses successfully removed from the house

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

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



Unsafe

Orphaned water heaters have oversized flues after a furnace is removed. Spillage should not exceed 2 minutes, if present.

Tools:

1. Smoke pencil

Title	Specification(s)	Objective(s)
2.0203.2b Flue gas removal (chimney liner or approved methods)	A chimney liner will be installed in accordance with the 2012 <i>IRC</i> or applicable <i>NFPA</i> standard	Allow water heater to vent properly Prevent damage to the chimney



Before

Unlined masonry chimney



After

Flue liner with rain cap

Connect chimney liner to appliance in accordance with applicable codes, NFPA, and manufacturer's installation instructions.

Tools

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

Materials

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

Title	Specification(s)	Objective(s)
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



Before

If spillage continues to exceed 2 min, additional repairs are required

Tools:

1. Smoke pencil



After

The elimination of the oversized chimney should prevent spillage



Retest for spillage. If spillage remains, more repair is needed.



Repipe the flue to eliminate the oversized chimney



When repairs have been completed, no spillage should occur

Title	Specification(s)	Objective(s)
2.0203.2d Required combustion air	The minimum required volume will be 50 cubic feet per 1,000 <i>Btu</i> /h in accordance with 2012 <i>IRC</i> 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 <i>IRC</i> 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 <i>CO</i> alarm If <i>CO</i> 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 <i>CO</i> levels do not exceed outdoor <i>CO</i> levels
2.0203.2g Occupant education	Occupants will be educated on the operation and maintenance of the <i>CO</i> 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 <i>CO</i> concentrations; <i>EPA</i> 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 <i>CO</i> hazards

2.0203.3 Draft Regulation—Category I Appliance

Topic: Combustion Safety

Subtopic: Vented Gas Appliances

Desired Outcome: Build-up of flue gasses prevented with proper drafting

For supporting material, see [Calculation of the Infiltration Credit](#) and [Referenced Standards](#).

Title	Specification(s)	Objective(s)
2.0203.3a Assessment	<p>The presence of an operable <i>draft regulator</i> will be verified</p> <p>Combustion venting systems will be inspected for damage, leaks, disconnections, and other safety hazards</p>	Determine if a <i>draft regulator</i> is present and working and if vent system is in good condition and installed properly
PA WAP Guidance:	Determine if draft regulator is required first.	
2.0203.3b Installation (if action is required)	<p>A <i>draft regulator</i> will be installed, if necessary</p> <p>Manufacturer specifications for installation will be followed (e.g., size, type, location)</p>	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	<p>All homes will have a functioning <i>CO</i> alarm</p> <p>If <i>CO</i> 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)</p>	<p>Ensure occupant health and safety</p> <p>Ensure indoor <i>CO</i> levels do not exceed outdoor <i>CO</i> levels</p>
2.0203.3e Occupant education	<p>Occupants will be educated on the operation and maintenance of the <i>CO</i> alarm</p> <p>Completed work on combustion appliances and recommended maintenance will be reviewed with occupant</p> <p>Occupant will be provided information regarding the health effects and risk of high <i>CO</i> concentrations; <i>EPA</i> provides possible expanded actions and offers client education information in an appendix to the protocols</p>	<p>Ensure occupant can operate and maintain installations</p> <p>Inform occupant regarding possible <i>CO</i> hazards</p>

Subtopic 2.0299 Additional Resources

2.0299.1 Combustion Appliance Depressurization Limits Table

Topic: Combustion Safety

Subtopic: Additional Resources

Desired Outcome: Ensure appliances meet manufacturer's certified negative pressure tolerance rating

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

PA WAP Guidance: 2.0299.1 Combustion Appliance Depressurization Limits Table	Follow the equipment manufacturer's tolerance levels for the specific combustion appliance. If the manufacturer's information is not available, then use this Depressurization Limits Table.
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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: <ul style="list-style-type: none"> 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: <ul style="list-style-type: none"> 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: <ul style="list-style-type: none"> 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: <ul style="list-style-type: none"> 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: <ul style="list-style-type: none"> 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: <ul style="list-style-type: none"> 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: <ul style="list-style-type: none"> 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: <ul style="list-style-type: none"> 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: <ul style="list-style-type: none"> Limit -25 pascals 	Ensure appliances meet manufacturer's certified negative pressure tolerance rating

Tools:

1. Manometer



A stand alone natural draft water heater

2.0299.1a

Atmospheric water heater only (Category I, natural draft), open-combustion appliances

Limit: -2 pascals



Natural draft water heater and natural draft furnace with common vent

2.0299.1b

Atmospheric water heater (Category I, natural draft) and atmospheric furnace (Category I, natural draft), common-vented, open-combustion appliances

Limit: -3 pascals



Common vent of natural draft appliances highlighted

2.0299.1b

Limit: -3 pascals



Category I 70% efficiency gas furnace with intake vent circled

2.0299.1c

Gas furnace or boiler, Category I or Category I fan-assisted, open-combustion appliances

Limit: -5 pascals



Category I 80% efficiency furnace

2.0299.1c

Limit: -5 pascals



Oil burner

2.0299.1c

Limit: -5 pascals



Oil burner

2.0299.1d

Oil or gas unit with power burner, low- or high-static pressure burner, open combustion appliances

Limit: -5 pascals



Wood-burning stove

2.0299.1e

Closed, controlled wood-burning appliances

Limit: -7 pascals



Pellet stove

2.0299.1g

Pellet stoves with exhaust fan and sealed vent

Limit: -15 pascals



Power-vented water heater

2.0299.1h

Gas appliances, Category III vented through the wall, forced draft, open-combustion appliance

Limit: -15 pascals



Two-pipe 90% efficiency furnace

2.0299.1i

Direct-vent, sealed combustion appliances with forced draft

Limit: -25 pascals

← *Forced draft appliance with sealed combustion*

Topic 2.03 Safety Devices

Subtopic 2.0301 Combustion Safety Devices

2.0301.1 Smoke Alarm

Topic: Safety Devices

Subtopic: Combustion Safety Devices

Desired Outcome: Properly installed smoke alarms

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

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

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



Before

Hard-wired smoke alarm mount with alarm missing



After

Installation of hard-wired smoke alarm

Paraphrased from 2012 IRC R314: Smoke alarms will receive their primary power from the building wiring when such wiring is served from a commercial source, and when primary power is interrupted, will receive power from a battery. Wiring will be permanent and without a disconnecting switch other than those required for overcurrent protection. Smoke alarms will be installed in the following locations: 1. In each sleeping room; 2. Outside each separate sleeping area in the immediate vicinity of the bedrooms; 3. On each additional story of the dwelling, including basements and habitable attics. Per WPN 14-01, compliance with NFPA 72 is also required.



Smoke alarms should be UL-217 rated and comply with NFPA 72. Homes should have hard-wired smoke alarms in all sleeping areas.

Title	Specification(s)	Objective(s)
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



Best Practice

All homes should have UL-217 rated smoke alarms.

Paraphrased from 2012 IRC R314: Smoke alarms will be permitted to be battery operated when installed in buildings without commercial power or when alterations or repairs do not result in the removal of interior wall or ceiling finishes exposing the structure to provide access for hard-wiring, unless there is an attic, crawl space, or basement available which could provide access.



Ceiling mounted smoke alarms can be battery-operated



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

2.0301.2 Carbon Monoxide Alarm or Monitor

Topic: Safety Devices

Subtopic: Combustion Safety Devices

Desired Outcome: Properly installed [CO](#) alarms or monitors

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

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

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



Before

Occupant safety is compromised when houses do not have CO alarms



After

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

Tools:

1. Hammer

Materials:

1. Nails

Paraphrased from 2012 IRC R315: An approved CO alarm will be installed outside of each separate sleeping area in the immediate vicinity of the bedrooms in all dwelling units. CO detectors will comply with UL 2075. Single-station CO alarms will comply with UL 2034 and will be installed in accordance with this code and the manufacturer's installation instructions. Per WPN 14-01, full compliance with ASHRAE 62.2.2013 and NFPA 720 is required.



1. Mount alarms to wall close to bedrooms.

2. Plug alarm into outlet. In addition, cord can be stapled into place.



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



Before

Houses should have carbon monoxide monitors installed near sleeping areas



After

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

Topic 2.04 Moisture

Subtopic 2.0401 Air Sealing

2.0401.1 Air Sealing Moisture Precautions

Topic: Moisture

Subtopic: Air Sealing

Desired Outcome: Ensure durability of repairs and reduce potential for occupant exposure to mold and other moisture-related hazards

For supporting material, see [Calculation of the Infiltration Credit](#) and [Referenced Standards](#).

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 <i>vapor retarder</i> a minimum of 6 mils in thickness Plastic, foil or any other Class 1 <i>vapor barrier</i> /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 <i>ASHRAE</i> 62.2-2010-2013 Unvented combustion appliances that are not listed to <i>ANSI</i> Z21.11.2 will be removed	Ensure durability of repairs Reduce potential for occupant exposure to mold and other moisture-related hazards
PA WAP Guidance:	Follow the ASHRAE 62.2-2013 Standard.	

Title	Specification(s)	Objective(s)
2.0401.1d Moisture precautions for exterior water	<p>Before air sealing basement or crawl space walls near wet areas, surface water pooling near the foundation will be addressed by:</p> <ul style="list-style-type: none"> • 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
PA WAP Guidance:	<p>See PA WAP Health and Safety Plan. Major drainage issues are beyond the scope of the WAP. Minor drainage repair must be cost-justified as an incidental expense.</p> <p>Gutter repair or replacement and installation falls under incidental repairs, and is limited to down spouts and spouting adjustments to capture water and mitigate. Excavation to redirect water runoff and water proofing a foundation is beyond PA WAP scope unless approved by DCED.</p> <p>Inform clients of the importance of cleaning and maintaining drainage systems and proper landscape design.</p>	

2.0401.2 Vented Crawl Space—Venting

Topic: Moisture

Subtopic: Air Sealing

Desired Outcome: Pollutants effectively vented

For supporting material, see [Calculation of the Infiltration Credit](#) and [Referenced Standards](#).

Title	Specification(s)	Objective(s)
2.0401.2a Venting	Venting will be performed in accordance with the 2012 IRC or the authority having jurisdiction	Provide ventilation for pollutant sources (e.g., moisture, radon, soil gases)

Subtopic 2.0402 Drainage

2.0402.1 Crawl Spaces—Drainage

Topic: Moisture

Subtopic: Drainage

Desired Outcome: Water and conditions conducive to mold growth, wood rot, and pests eliminated

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

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
PA WAP Guidance:	This requires a visual inspection only, actual re-grading of surface areas around the home may be beyond PA WAP scope of work unless approved by DCED. See PA WAP Health and Safety Plan. Inform clients of the importance of cleaning and maintaining drainage systems and proper landscape design.	
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
PA WAP Guidance:	Apply visual inspection for this SWS. Do not implement actual work. This could be cause for deferral until owner/occupant can resolve moisture issues.	
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
PA WAP Guidance:	See PA WAP Health and Safety Plan. Major drainage issues are beyond the scope of the WAP. Minor drainage repair must be cost-justified as an incidental expense. Contact DCED before installing a new sump pump or drains where one does not already exist.	

Subtopic 2.0403 Vapor Barriers

2.0403.1 Vented Crawl Spaces—Ground Moisture Barrier

Topic: Moisture

Subtopic: Vapor Barriers

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

For supporting material, see [Calculation of the Infiltration Credit](#) and [Referenced Standards](#).

Title	Specification(s)	Objective(s)
2.0403.1a Material Integrity	Care will be taken to prevent punctures during installation	Protect ground moisture barrier from damage during other crawl space work
2.0403.1b Coverage	A ground moisture barrier that covers 100% of the exposed crawl space floor will be installed	Reduce ground moisture entering the crawl space



Before

Uncovered crawl space floors can cause moisture damage



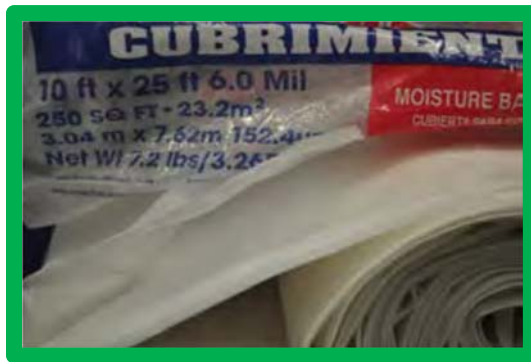
After

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

Materials:

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

Title	Specification(s)	Objective(s)
2.0403.1c Material specification	<p>A ground moisture barrier with a rating of no more than 0.1 perm will be used</p> <p>A ground moisture barrier will be used that meets tear and puncture resistance standard ASTM E1745</p> <p>Homeowner will be advised that all plastic is biodegradable and will have a life span much shorter than the home (5 years), and it will need replacing to remain effective</p>	Ensure crawl space is accessible for service and maintenance without damaging the integrity of the ground moisture barrier



After

Barrier must be at least 4 mil, able to withstand puncture and last 5 yrs

Materials:

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

The higher a material's perm rating, the more vapor can pass through said material. Drywall typically has a perm rating of approximately 50.

For vapor retarders in basements and crawl spaces, SWS calls for materials with a perm rating of <0.5 (which translates to 4mil or thicker).

From 2007 IRC definition of vapor retarders:
 Class I: ≤ 0.1 perm (called impermeable),
 Class II: 0.1 to 1.0 perm (called semi-impermeable),
 Class III: 1.0 perm to 10 perms (called semi-permeable).

Title	Specification(s)	Objective(s)
2.0403.1d Overlap seams	When seams exist, they will be overlapped a minimum of 12" using <i>reverse or upslope lapping technique</i>	Keep water under the liner Reduce the likelihood of damage at seams



Before

Ground moisture barriers help keep moisture from permeating floor.

Tools:

1. Stapler
2. Utility knife
3. Drill

Materials:

1. Ballast
2. Plastic sheeting (at least 4mil)
3. Furring strips
4. Seam tape - moisture resistant



After

Ground moisture barrier overlaps at least 12 inches and is securely fastened



Securely fasten moisture barrier to wall at least 6 inches from ground



Overlap seams at least 12 inches, using a shingle method to keep water out

Title	Specification(s)	Objective(s)
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	Prevent movement of the ground moisture barrier



Before

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

Tools:

1. Stapler
2. Drill

Materials:

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



After

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



Seams can be taped to prevent water leakage



Ballast or fasteners can hold barrier in place securely

2.0403.2 Closed Crawl Spaces—Ground Moisture Barriers

Topic: Moisture

Subtopic: Vapor Barriers

Desired Outcome: Durable, effective [air barrier](#) and ground moisture barrier provide ongoing access and minimize ground vapor

For supporting material, see [Calculation of the Infiltration Credit](#) and [Referenced Standards](#).

Title	Specification(s)	Objective(s)
2.0403.2a Material Integrity	Care will be taken to prevent punctures during installation	Protect ground moisture barrier from damage during other crawl space work
2.0403.2b Coverage	<p>An air barrier and ground moisture barrier, covering 100% of the exposed crawl space floor, will be installed and sealed to the wall's air and moisture barrier in accordance with ASTM E1643 and manufacturer's recommendations</p> <p>Ground moisture barrier will be fastened to ground in accordance with manufacturer's recommendations and extend a minimum of 6 inches up the foundation wall</p>	<p>Reduce ground moisture entering the crawl space</p> <p>Create a continuous and durable connection between the wall and ground air and moisture barriers</p>



Before

Uncovered crawl space floors can lead to moisture issues



After

Ground moisture barrier should cover 100% of floor and at least 6" of walls

Materials:

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

Title	Specification(s)	Objective(s)
2.0403.2c Material specification	<p>A ground moisture barrier with a rating of no more than 0.1 perm will be used</p> <p>A ground moisture barrier will be used that meets tear and puncture resistance standard ASTM E1745</p> <p>Homeowner will be advised that all plastic is biodegradable and will have a life span much shorter than the home (5 years), and it will need replacing to remain effective</p>	<p>Reduce ground vapor entering the crawl space</p> <p>Ensure crawl space is accessible for service and maintenance without destroying the integrity of the moisture barrier</p>



Best Practice

Barrier must be at least 4 mil, able to withstand puncture and last 5 yrs

Materials:

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

The higher a material's perm rating, the more vapor can pass through said material. Drywall typically has a perm rating of approximately 50.

For vapor retarders in basements and crawl spaces, SWS calls for materials with a perm rating of <0.5 (which translates to 4mil or thicker).

From 2007 IRC definition of vapor retarders:

- Class I: ≤ 0.1 perm (called impermeable),
- Class II: 0.1 to 1.0 perm (called semi-impermeable),
- Class III: 1.0 perm to 10 perms (called semi-permeable).

Title	Specification(s)	Objective(s)
2.0403.2d Overlap seams	<p>When seams exist, they will be overlapped a minimum of 12" with <i>reverse or upslope lapping technique</i></p> <p>For wall to floor connection, the wall moisture barrier will be installed under the ground moisture barrier</p>	Keep water under the liner



Before

Ground moisture barriers help keep moisture from permeating floor



After

Ground moisture barrier overlaps at least 12 inches and is securely fastened

Tools:

1. Stapler
2. Utility knife
3. Drill

Materials:

1. Ballast
2. Plastic sheeting (at least 4mil)
3. Furring strips
4. Moisture-resistant adhesive tape



Securely fasten moisture barrier to wall at least 6 inches from ground



Overlap seams at least 12 inches, using a shingle method to keep water out

Title	Specification(s)	Objective(s)
2.0403.2e Fastening	The <i>air barrier</i> and ground moisture barrier will be fastened to the ground to prevent movement in accordance with <i>ASTM</i> E1643 and manufacturer's recommendations	Prevent movement and uplift of the <i>air barrier</i> and ground moisture barrier



Before

Moisture barrier needs to be held in place with more permanent fasteners

Tools:

1. Stapler
2. Drill



After

Ballast or fasteners should be used to hold barrier in place securely

Materials:

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

2.0403.2f Sealing seams	A durable sealant compatible with the <i>air barrier</i> and ground moisture barrier will be used	Maintain continuous <i>air barrier</i> and ground moisture barrier
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Before

Crawl spaces lacking moisture barrier risk moisture penetration of floor



Seams can be taped to prevent water leakage



After

Ground moisture barriers in unvented spaces should be sealed

Tools:

1. Utility knife

Materials:

1. Moisture-resistant adhesive tape

Tape (overlapped) floor seams to prevent movement and water leakage



Title	Specification(s)	Objective(s)
2.0403.2g Air barrier, ground moisture barrier penetrations, including fastener penetrations	<p>A durable sealant, compatible with the <i>air barrier</i> and ground moisture barrier, will be used</p> <p>Physical attachments will be provided where practical (e.g., masonry columns, footings)</p>	<p>Maintain continuous <i>air barrier</i> and ground moisture barrier</p>
2.0403.2h Drainage	<p>The <i>air barrier</i> and ground moisture barrier will not interfere with the established drainage pattern</p>	<p>Ensure proper drainage</p>
2.0403.2i Drainage points	<p>Interior drainage collection points will be accessible from above and below the <i>air barrier</i> and ground moisture barrier</p>	<p>Remove water above and below the <i>air barrier</i> and ground moisture barrier</p>

2.0403.3 Closed Crawl Spaces—Vapor Retarders on Walls

Topic: Moisture

Subtopic: Vapor Barriers

Desired Outcome: Durable, effective [vapor retarder](#) minimizes leakage from ground and air

For supporting material, see [Referenced Standards](#).

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	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	Prevent ground moisture penetration

Subtopic 2.0404 Space Conditioning

PA WAP Guidance: 2.0404 Space Conditioning	Space conditioning (dehumidifiers) are not an allowable measure in PA. Do not apply the SWS's in Subtopic 2.0404.
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Topic 2.05 Radon

PA WAP Guidance: 2.05 Radon	<p>See the PA WAP Health & Safety Plan. Testing of radon and remediation of dangerous radon levels is beyond the scope of DOE WAP.</p> <p>Homes where known radon levels are 4pCi/L or higher will be deferred until the client provides accurate and plausible test results indicating that radon levels no longer present a dangerous situation. Homes requiring remediation will be deferred until remediation is accomplished through some other funding source.</p> <p>DOE H&S funds will be utilized only for basic precautions to reduce the likelihood of making radon issues worse (for example, covering exposed dirt with a vapor barrier).</p> <p>Provide all clients with a copy of EPA's consumer's guide to radon. Radon Information Form is provided as an attachment in the PA WAP H&S Plan.</p>
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Subtopic 2.0501 Air Sealing

2.0501.1 Radon—Air Sealing Considerations

Topic: Radon

Subtopic: Air Sealing

Desired Outcome: Work completed without increasing occupant exposure to radon

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

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

Desired Outcome: Work completed without increasing occupant exposure to radon

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

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

Topic 2.06 Electrical

Subtopic 2.0601 Knob and Tube Wiring

2.0601.1 Knob and Tube Wiring

Topic: Electrical

Subtopic: Knob and Tube Wiring

Desired Outcome: Live unsafe wiring identified and brought to local codes

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

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

<p>PA WAP Guidance: 2.0601.1 Knob and Tube Wiring</p>	<p>See PA WAP Health and Safety Plan. DOE H&S funds (max of \$975) may be utilized for the necessary remediation of the knob and tube wiring if elimination of such hazards are necessary before, or as a result of, installation of weatherization materials.</p> <p>Visual Inspection for presence and conditions of knob and tube wiring. Check for alternations that may create an electrical hazard. Test if wiring is active. If it is active and funds permit, utilize a qualified electrician for removal. If it is not active, remove wiring.</p> <p>When dangerous conditions exist and remediation would be cost-prohibitive, or the dwelling unit has been condemned for electrical, plumbing, or other issues, the home will be deferred.</p> <p>Provide clients information on overloading circuits and electrical safety/risks.</p>
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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



Knob and tube wiring should be identified before work begins

Distinctive “knobs” are highlighted. This wiring can be a safety hazard.



Title	Specification(s)	Objective(s)
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



Before

Knob & tube wiring needs to be tested to determine if still live. This tester shows that Red=live. Refer to tester manufacturer instructions when testing.

Tools:

1. Non-contact wire tester



After

Live wiring should be dammed or professionally disabled before insulating

Title	Specification(s)	Objective(s)
2.0601.1c Isolation and protection	<p>Live knob and tube will not be covered or surrounded; required by the National Electrical Code (NEC) or authority having jurisdiction</p> <p>A licensed electrical contractor will inspect and certify wiring to be safe and place a warning at all entries to the attic about the presence of knob and tube wiring</p> <p>A dam that does not cover the top will be created to separate insulation from the wire path</p>	<p>Ensure occupant safety</p> <p>Preserve the integrity and safety of the house</p>



Before

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

Tools:

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



After

Dams should be installed to hold back loose fill insulation

Materials:

1. Plywood
2. Drywall
3. Fasteners

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

Title	Specification(s)	Objective(s)
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Have a certified electrician verify that wiring is safe to work around



A sign should be posted at all entrances to warn of knob & tube



Warning sign should remind to contact certified electrician for repairs



Many jurisdictions require a sign in Spanish as well



Damming should extend above installed height of insulation



With dams in place, insulation can begin

Title	Specification(s)	Objective(s)
2.0601.1d Replacement	<p>Exposed wiring will be replaced with new appropriate wiring in accordance with the NEC and local codes</p> <p>Old wiring will be rendered inoperable by licensed electrician in accordance with the NEC and local codes</p>	<p>Ensure occupant safety</p> <p>Preserve the integrity and safety of the house</p>



Before

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

Tools:

1. Non-contact wire tester



After

If possible, k&t wiring should be disabled and replaced with modern wiring

Materials:

1. Romex as needed

NEC guidelines and local jurisdictions have many codes dealing with the treatment of knob & tube wiring. Check your local codes.



The entire knob and tube system should be disabled



Many electricians will remove old exposed wiring to prevent reactivation



Exposed knob and tube should be replaced with modern wiring



With modern wiring in place and old k&t disabled, insulation can begin

Topic 2.07 Occupant Education and Access

Subtopic 2.0701 Basements and Crawl Spaces

2.0701.1 Crawl Spaces—Providing Access

Topic: Occupant Education and Access

Subtopic: Basements and Crawl Spaces

Desired Outcome: Access to the [closed crawl space](#) is controlled and the ground moisture barrier is protected to maintain the integrity of the system

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

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

Desired Outcome: Posted signs inside of the crawl space provide essential safety and maintenance information to occupant and users of the crawl space

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



Crawl space access points should have signage to alert occupant and workers



Best Practice
Sign should be highly-visible, securely fastened, and durable

Title	Specification(s)	Objective(s)
2.0701.2b Sign content	<p>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</p> <p>Anyone entering the crawl space will be alerted that immediate repairs are needed in case of damage</p> <p>Installer contact information will be included on the sign in case there are questions or needs for repairs</p>	<p>Prevent damage to the crawl space after upgrade</p> <p>Educate anyone entering the crawl space</p> <p>Provide occupants with a way to contact the installer</p>



Best Practice

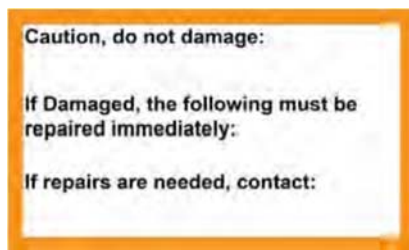
Mount sign where clearly visible to anyone entering crawl space

Tools:

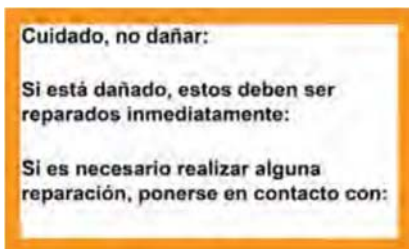
1. Printer
2. Staple gun

Materials:

1. Paper
2. Laminant
3. Staples



Be sure sign includes relevant information to aid occupant in repairs



Hacer la señal en español también

2.0701.2c Hazard warning	Language prohibiting storage of hazardous and flammable materials will be provided on site	<p>Prevent storage of hazardous or flammable materials in the crawl space</p> <p>Maintain indoor air quality</p> <p>Prevent a fire hazard</p>
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Best Practice

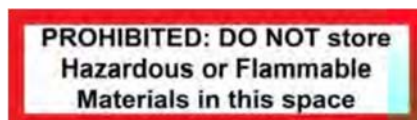
Mount sign where clearly visible to anyone entering crawl space

Tools:

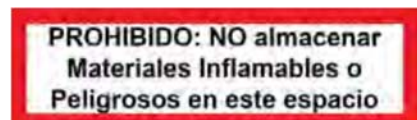
1. Printer
2. Staple gun

Materials:

1. Paper
2. Laminant
3. Staples



Alert those entering the crawl space never to store hazardous materials



Hacer la señal en español también

2.0701.3 Crawl Space—Occupant Education

Topic: Occupant Education and Access

Subtopic: Basements and Crawl Spaces

Desired Outcome: Occupants educated on the crawl space system and how to maintain it

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

Subtopic 2.0702 Installed Equipment

2.0702.1 Warranty and Service Agreement

Topic: Occupant Education and Access

Subtopic: Installed Equipment

Desired Outcome: Occupants provided recourse for failures in materials, workmanship, and serviceability and informed of potential hazards

Title	Specification(s)	Objective(s)
2.0702.1a Warranty	A minimum 1-year warranty for materials, workmanship, and serviceability will be provided to occupants upon completion of work	Provide recourse to occupants for failures in materials, workmanship, and serviceability
PA WAP Guidance:	This is required only for installed equipment (HVAC, refrigerators, and ventilation fans).	
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
PA WAP Guidance:	Warranties more than 1 year are optional and at the discretion of PA WAP subgrantees.	
2.0702.1c General conditions	<p>At a minimum, the following concerns and warnings will be addressed within the warranty:</p> <ul style="list-style-type: none">• Possible drying and shrinking effects• Storage of hazardous and flammable materials• Mold	Educate occupants on potential hazards
PA WAP Guidance:	Include information in the warranty that it does not cover possible drying and shrinking effects, storage of hazardous and flammable materials, and mold.	

Chapter 3: Air Sealing

Minimum testing for air sealing:

- Blower door testing
- Duct pressurization or Pressure pan testing for warm air systems

Auditors must perform two blower door tests for each unit (one pre-weatherization and one post-weatherization) and document in the client file. Using a blower door to monitor the progress of the crew's air sealing work (referred to as blower door-guided air sealing) should be conducted.

Window Replacements

There must be complete photographic and written documentation in the Client File of all existing windows to be replaced, detailing the rationale for replacement, especially if not repairing the windows.

Documentation must indicate that all replacement windows are R-5 (or equivalent U-value) replacement windows.

Door Replacements

There must be complete photographic and written documentation in the Client File of all doors to be replaced, detailing the rationale for replacement, especially instead of repairing the door(s).

Adhere to the air sealing-related topics referenced in the *DCED Directive: Health and Safety*.

Crosswalk of Health & Safety SWS with the ANSI/BPI 1100 Energy Auditing Standard

The SWS for Health and Safety will apply to Auditors as they follow the ANSI-BPI-1100-T-2014 Home Energy Auditing Standard section 10.

3. Air Sealing SWS

Topic 3.10 Attics

Subtopic 3.1001 Penetrations and Chases

3.1001.1 Penetrations and Chases

Topic: Attics

Subtopic: Penetrations and Chases

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

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

Title	Specification(s)	Objective(s)
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3.1001.1d High temperature application



Before

Gaps around combustion exhaust flues need to be sealed



After

Sealed penetrations and chases should utilize high-temperature materials

Tools:

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

Materials:

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

See 3.1402.1c for Clearance Requirements



1. Prepare work area by removing any debris



2. Use high-temperature caulking (600F min)



3. Apply first ring of caulking to match shape of opening



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



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



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

3.1001.2 Chase Capping

Topic: Attics

Subtopic: Penetrations and Chases

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

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

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



Before

Investigate under insulation in chases to verify they are undamaged



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

Tools:

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



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



2. Clear away insulation and debris to allow inspection



3. Carefully investigate areas with high potential for water leaks

Title	Specification(s)	Objective(s)
3.1001.2b Standard chase (interior walls covered with drywall or plaster)	Entire opening will be spanned with <i>rigid material</i> Material will be cut to fit and fastened as required	Reduce opening to what can be sealed with sealant



Before

Unsealed standard chases covered with drywall can be leakage points



After

The air barrier is maintained by capping chases with rigid material

Tools:

1. Drill/screwdriver
2. Caulk gun

Materials:

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



1. Clear area of debris and insulation in preparation for work



2. Apply sealant all the way around opening



3. Trim rigid material, such as drywall or XPS, to size and place over sealant



4. Fasten rigid material appropriately, such as with screws

Title	Specification(s)	Objective(s)
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 <i>IRC</i> R302.9	Prevent a fire hazard



Before

Unsealed standard chases covered with drywall can be leakage points



After

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

EPS or bead-board are **not** acceptable materials.

Tools:

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

Materials:

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



Sealing with drywall reduces overall combustibility of paneled chases



Sealing with XPS also reduces overall combustibility of paneled chases

Title	Specification(s)	Objective(s)
3.1001.2d Support	<i>Support material</i> will be installed for spans wider than 24", except when <i>air barrier</i> material is rated to span greater distance under load (e.g., wind, insulation)	Ensure seal stays in place and does not sag



Before

Spans greater than 24 inches require additional bracing before capping



After

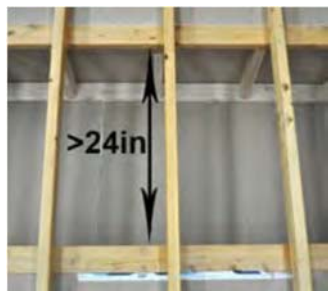
Support should prevent cap from sagging or moving

Tools:

1. Drill
2. Saw
3. Tape measure

Materials:

1. Lumber
2. Drywall
3. Fasteners



Create bracing to support spans larger than 24", either from above or below



When supporting from above, apply adhesive between drywall and bracing



Bracing can be screwed to drywall before capping chase



Ensure new bracing is secure by using screws to fasten to joist



Once chase is capped, it is now ready to be sealed along framing

Title	Specification(s)	Objective(s)
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



Before

Chases need to be capped and sealed to prevent leakage



After

Chase is sealed along all cracks, gaps, and penetrations

Tools:

1. Spray foam gun
2. Caulk gun

Materials:

1. Spray foam
2. Caulk

Always wear protective gloves when working with sealants.



1. Chase has been capped but needs to be sealed

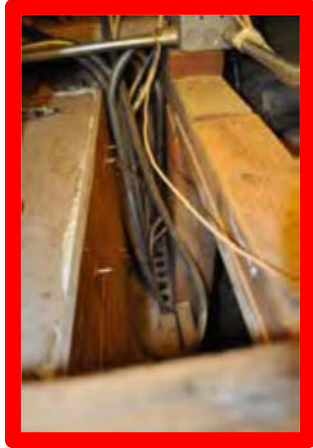


2. Sealant is used to fill in all cracks and gaps along edges of chase cap



3. Cap is sealed

Title	Specification(s)	Objective(s)
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



Before

Chases need to be capped and sealed to prevent leakage



After

Chase is sealed along all cracks, gaps, and penetrations

Tools:

1. Spray foam gun
2. Caulk gun

Materials:

1. Spray foam
2. Caulk

Always wear protective gloves when working with sealants.



1. Sealant is used to fill in cracks and gaps along edges of chase cap



2. Extend seal along adjacent framing

3.1001.3 Walls Open to Attic—Balloon Framing and Double Walls

Topic: Attics

Subtopic: Penetrations and Chases

Desired Outcome: Continuous [air barrier](#) prevents air leakage and moisture movement between the attic and conditioned space

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

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



Before

Wall cavities are open to attic



After

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

Tools:

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

Materials:

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

Title	Specification(s)	Objective(s)
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3.1001.3b Sealing methods



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



Option 2: Bridge cavities with spray foam



Option 3, Step 1: Apply sealant around opening and on surrounding framing



Option 3, Step 2, Option A: Cap with XPS and seal exposed joints



Option 3, Step 2, Option B: Cap with drywall and seal exposed joints

Title	Specification(s)	Objective(s)
3.1001.3c Support	<i>Support material</i> will be installed for spans wider than 24", except when <i>air barrier</i> material is rated to span greater distance under load (e.g., wind, insulation)	Ensure seal stays in place and does not sag



Before

Spans greater than 24 inches require additional bracing before capping



After

Support should prevent cap from sagging or moving

Tools:

1. Drill
2. Saw
3. Tape measure

Materials:

1. Lumber
2. Drywall
3. Fasteners



Create bracing to support spans larger than 24", either from above or below



When supporting from above, apply adhesive between drywall and bracing



Bracing can be screwed to drywall before capping chase



Ensure new bracing is secure by using screws to fasten to joist



Once chase is capped, it is now ready to be sealed along framing

Title	Specification(s)	Objective(s)
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



Before

Balloon framing needs to be capped and sealed to prevent leakage

Tools:

1. Spray foam gun
2. Caulk gun



After

All edges of the cap should be sealed to surrounding surfaces

Materials:

1. Spray foam
2. Caulk



For rigid material applications, extend sealant along all seams



Extend sealant or SPF along joist to seal all gaps

Title	Specification(s)	Objective(s)
3.1001.3e Adjacent framing	<p>All remaining gaps at the top of the opening will be sealed</p> <p>OR</p> <p>All remaining gaps at the top of the chase will be sealed</p>	<p>Ensure airtight seal from one finished side of the wall assembly to the other</p>



Before

Balloon framing needs to be capped and sealed to prevent leakage

Tools:

1. Spray foam gun
2. Caulk gun



After

All edges of the cap should be sealed to surrounding surfaces, including adjacent framing

Materials:

1. Spray foam
2. Caulk



For rigid material applications, sealant should be applied to framing



When using SPF to bridge cavity, extend SPF along joist and adjacent framing

3.1001.10 Non-Insulation Contact (IC) Recessed Light

Topic: Attics

Subtopic: Penetrations and Chases

Desired Outcome: Ensure safety from fire and prevent air leakage

For supporting material, see [Referenced Standards](#).

Title	Specification(s)	Objective(s)
3.1001.10a Air barrier system	<p>A fire-rated <i>air barrier</i> system (i.e. equivalent to 5/8 fire code gypsum wallboard) will be used to separate non-<i>IC</i> rated recessed lights from insulation, using one of the methods below:</p> <p>A fire-rated airtight closure taller than surrounding attic insulation will be placed over non- <i>IC</i> rated recessed lights</p> <p>OR</p> <p>The non- <i>IC</i> rated light fixture will be replaced with an airtight and <i>IC</i> - rated fixture</p> <p>OR</p> <p>The fixture(s) may be replaced with surface mounted fixture and opening sealed</p>	<p>Prevent a fire hazard</p> <p>Prevent air leakage through fixture</p>
3.1001.10b Enclosure top	<p>The top-fire rated enclosure material will have an R-value of 0.5 or less</p> <p>The top of the enclosure will be left free of insulation</p>	<p>Prevent heat build up</p>
3.1001.10c Clearance	<p>The entire closure will maintain a 3" clearance between the closure and the fixture including wiring, box, and ballast</p>	<p>Keep an air space around the fixture</p>
3.1001.10d Sealants and weather stripping	<p>Caulk, mastic, or foam will be used on all edges, gaps, cracks, holes, and penetrations of closure material only</p>	<p>To prevent air leakage, completely adhere the sealant to all surfaces to be sealed</p>

Subtopic 3.1002 Open Stairwells

3.1002.1 Interior with Sloped Ceiling

Topic: Attics

Subtopic: Open Stairwells

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

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

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 <i>rigid material</i> 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)	Material will be used that can be exposed to the interior of the house	Prevent a fire hazard
3.1002.1d Support	<i>Support material</i> will be installed for spans wider than 24", except when <i>air barrier</i> 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

Title	Specification(s)	Objective(s)
3.1002.1f Perimeter sealing	<p><i>Air barrier</i> will be extended on all four sides from finished ceiling or existing framing to the new barrier</p> <p>Access will be gained as needed (e.g., pull flooring)</p>	Create a continuous <i>air barrier</i>

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

Topic: Attics

Subtopic: Open Stairwells

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

Title	Specification(s)	Objective(s)
3.1002.2a Pre-inspection	<p>An inspection will be conducted for mold, water leaks, and water damage before sealing an open stairwell</p> <p>Repairs will be completed before work begins</p>	Repair moisture-related issues
3.1002.2b Option 1: bring stairwell inside	<p>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</p> <p>OR</p> <p>Airtight seal will be provided between level of new closure or cap and interior ceiling around perimeter</p> <p>Access will be gained as needed (e.g., pull flooring)</p>	<p>Prevent air leakage through stairwell between conditioned space and attic</p> <p>Ensure the insulated panel is lightweight and easy for the occupant to use on an ongoing basis</p> <p>Support insulation</p> <p>Bring the stairwell inside of the <i>thermal boundary</i></p> <p>Ensure the new closure ties into the existing <i>air barrier</i> on all sides</p>

Title	Specification(s)	Objective(s)
3.1002.2c Option 2: keep stairwell outside	<p>An <i>air barrier</i> will be created and insulation material will be continuously installed across all surfaces of stairwell, including weather-stripped and insulated doors</p> <p>OR</p> <p>All cavities between stairs and conditioned space will be insulated and tested to resist air flow (e.g., walls, floors, landings, under stairs)</p> <p>Door will be weatherstripped and insulated</p> <p>OR</p> <p>A combination of the above methods can be used</p>	<p>Prevent air leakage</p> <p>Provide continuous <i>thermal boundary</i></p> <p>Maximize thermal performance</p>
3.1002.2d Support	<p><i>Support material</i> will be installed for spans wider than 24", except when <i>air barrier</i> material is rated to span greater distance under load (e.g., wind, insulation)</p>	<p>Ensure seal stays in place and does not sag</p>
3.1002.2e Joint seal	<p>Continuous, airtight seals will be provided around seams, cracks, joints, edges, penetrations, and connections</p>	<p>Provide airtight, durable seal that does not move, bend, or sag</p>
3.1002.2f Perimeter sealing	<p><i>Air barrier</i> will be extended on all four sides from finished ceiling or from existing framing to the new barrier</p> <p>Access will be gained as needed (e.g., pull flooring)</p>	<p>Create a continuous <i>air barrier</i></p>

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

Topic: Attics

Subtopic: Open Stairwells

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

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 <i>air barrier</i> 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 <i>thermal boundary</i> Maximize thermal performance
3.1002.3c Support	<i>Support material</i> will be installed for spans wider than 24", except when <i>air barrier</i> 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	<i>Air barrier</i> 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 <i>air barrier</i>

Subtopic 3.1003 Dropped Ceilings and Soffits

3.1003.1 New Ceiling Below Original—Old Ceiling Intact or Repairable

Topic: Attics

Subtopic: Dropped Ceilings and Soffits

Desired Outcome: Continuous [air barrier](#) prevents air leakage and moisture movement between the attic and conditioned space

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
PA WAP Guidance:	If area is significant (e.g. more than one room or an entire first floor), contact DCED for guidance.	

Title	Specification(s)	Objective(s)
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3.1003.1b Sealing methods



Before

Damage to an older ceiling reveals the new ceiling below



After

Rigid material sealed in place creates an air barrier

Tools:

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

Materials:

1. Caulk sealant
2. Rigid material -- XPS or Drywall
3. Spray foam
4. Fasteners
5. Dense packable insulation
6. Wrapped fiberglass batts



Prepare work area by removing existing insulation and debris



Option 1, Step 1: Run a bead of sealant around damage in old ceiling



Option 1, Step 2: Cover openings with rigid material, either XPS or drywall



Option 2: Seal with rigid material along face of stud cavities



Option 3: Dense pack cavities through fastened wood plate



Option 4: Bridge cavities at new ceiling level with wrapped batts and SPF



Whatever option chosen, test with chemical smoke to verify no leakage

Title	Specification(s)	Objective(s)
3.1003.1c Support	<i>Support material</i> will be installed for spans wider than 24", except when <i>air barrier</i> material is rated to span greater distance under load (e.g., wind, insulation)	Ensure seal stays in place and does not sag



Before

Spans greater than 24 inches require additional bracing before capping



After

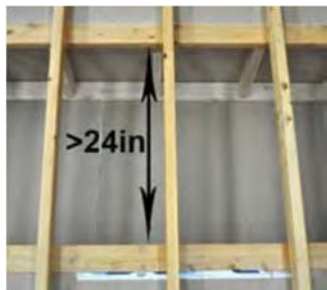
Support should prevent cap from sagging or moving

Tools:

1. Drill
2. Saw
3. Tape measure

Materials:

1. Lumber
2. Drywall
3. Fasteners



Create bracing to support spans larger than 24", either from above or below



When supporting from above, apply adhesive between drywall and bracing



Bracing can be screwed to drywall before capping chase



Ensure new bracing is secure by using screws to fasten to joist



Once chase is capped, it is now ready to be sealed along framing

Title	Specification(s)	Objective(s)
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



Before

Damage to an older ceiling reveals a newer ceiling below



After

No gaps should remain after sealant is applied

Tools:

1. Spray foam gun
2. Caulk gun

Materials:

1. Caulk
2. Spray foam



1. Apply sealant to surrounding surfaces before setting cap in place



2. Sealant should extend along joists and into seams at top plates



3. Once cap is set, apply sealant to remaining gaps and along all seams

Title	Specification(s)	Objective(s)
3.1003.1e Adjacent framing	<p>All remaining gaps will be sealed at the top of the dropped ceiling</p> <p>OR</p> <p>All remaining gaps at the top of the chase will be sealed</p>	<p>Provide airtight framing from one finished side of the dropped ceiling to the other</p>



Before

Damage to an older ceiling reveals the new ceiling below



After

No gaps should remain after spray foam is applied

Tools:

1. Spray foam gun
2. Caulk gun

Materials:

1. Caulk
2. Spray foam



1. Caulk along all joists before setting cap



2. Use sealant to fill all remaining gaps

3.1003.2 Ceiling Leaks Not Repairable—No Air Barrier Above

Topic: Attics

Subtopic: Dropped Ceilings and Soffits

Desired Outcome: Continuous [air barrier](#) prevents air leakage and moisture movement between the attic and conditioned space

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
PA WAP Guidance:	If area is significant (e.g. more than one room or an entire first floor), contact DCED for guidance.	

Title	Specification(s)	Objective(s)
3.1003.2c Support	<i>Support material</i> will be installed for spans wider than 24", except when <i>air barrier</i> material is rated to span greater distance under load (e.g., wind, insulation)	Ensure seal stays in place and does not sag



Before

Spans greater than 24 inches require additional bracing before capping



After

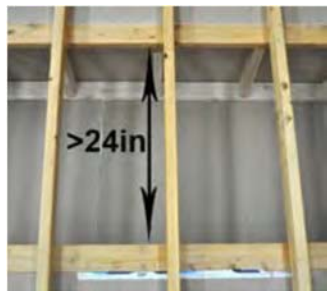
Support should prevent cap from sagging or moving

Tools:

1. Drill
2. Saw
3. Tape measure

Materials:

1. Lumber
2. Drywall
3. Fasteners



Create bracing to support spans larger than 24", either from above or below



When supporting from above, apply adhesive between drywall and bracing



Bracing can be screwed to drywall before capping chase



Ensure new bracing is secure by using screws to fasten to joist



Once chase is capped, it is now ready to be sealed along framing

Title	Specification(s)	Objective(s)
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



Before

Dropped soffits need to be capped and sealed to prevent leakage



After

No gaps should remain after sealant is applied

Tools:

1. Spray foam gun
2. Caulk gun

Materials:

1. Caulk
2. Spray foam



1. Apply sealant to surrounding surfaces before setting cap in place



2. Sealant should extend along surround joist and into seams at top plates



3. Once cap is set, apply sealant to remaining gaps and along all seams

Title	Specification(s)	Objective(s)
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



Before

Dropped soffits need to be capped and sealed to prevent leakage



After

No gaps should remain after sealant is applied along adjacent framing

Tools:

1. Spray foam gun
2. Caulk gun

Materials:

1. Caulk
2. Spray foam



- 1.** Sealant should have been along all joists and adjacent framing before cap was set



- 2.** Additional sealant should fill in all remaining gaps after cap has been set

3.1003.3 Above Closets and Tubs

Topic: Attics

Subtopic: Dropped Ceilings and Soffits

Desired Outcome: Continuous [air barrier](#) prevents air leakage and moisture movement between the attic and conditioned space

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



Before

Unsealed drop soffits over tubs and closets



After

Capped soffits minimize leakage to and from unconditioned spaces

Title	Specification(s)	Objective(s)
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3.1003.3b Above closets and tubs



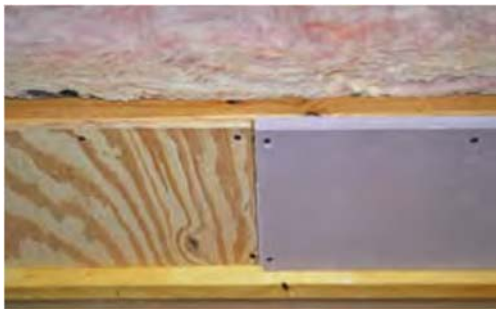
Option 1, Step 1: Apply sealant to top plates or other relevant surfaces



Option 1, Step 2: Cover soffit with rigid material, such as drywall



Option 1, Step 3: Secure the rigid material with screws



Option 2: Cover face of stud bay with rigid material, like XPS or plywood



Option 3: Dense pack cavity through fastened wood cap



Option 4: Bridge stud bay with wrapped fiberglass and spray foam



All Options: Test with smoke pencil to verify no air movement

Title	Specification(s)	Objective(s)
3.1003.3c Support	<i>Support material</i> will be installed for spans wider than 24", except when <i>air barrier</i> material is rated to span greater distance under load (e.g., wind, insulation)	Ensure seal stays in place and does not sag



Before

Spans greater than 24 inches require additional bracing before capping



After

Support should prevent cap from sagging or moving

Tools:

1. Drill
2. Saw
3. Tape measure

Materials:

1. Lumber
2. Drywall
3. Fasteners



Create bracing to support spans larger than 24", either from above or below



When supporting from above, apply adhesive between drywall and bracing



Bracing can be screwed to drywall before capping chase



Ensure new bracing is secure by using screws to fasten to joist



Once chase is capped, it is now ready to be sealed along framing

Title	Specification(s)	Objective(s)
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



Before

Uninsulated soffits can cause leakage to and from unconditioned spaces



After

No gaps should remain after spray foam is applied

Tools:

1. Spray foam gun
2. Caulk gun

Materials:

1. Caulk
2. Spray foam



1. Caulk surrounding surfaces before setting cap in place



2. Sealant should extend along surround joist and into seams at top plates



3. Once cap is set, apply sealant to remaining gaps and along all seams

Title	Specification(s)	Objective(s)
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



Before

Dropped soffits need to be capped and sealed to prevent leakage



After

No gaps should remain after sealant is applied along adjacent framing

Tools:

1. Spray foam gun
2. Caulk gun

Materials:

1. Caulk
2. Spray foam



1. Apply sealant to surrounding surfaces before setting cap in place



2. Sealant should extend along adjacent framing and into seams at top plate



3. Additional sealant should fill in all remaining gaps after cap has been set

3.1003.4 Dropped Ceilings

Topic: Attics

Subtopic: Dropped Ceilings and Soffits

Desired Outcome: Continuous [air barrier](#) prevents air leakage and moisture movement between the attic and conditioned space

Title	Specification(s)	Objective(s)
3.1003.4a Pre-inspection	<p>An inspection will be conducted for mold, water leaks, and water damage before sealing a dropped ceiling or soffit</p> <p>Repairs will be completed before work begins</p>	Repair moisture-related issues
3.1003.4b Sealing methods	<p>Entire opening will be spanned with rigid material installed in line with the ceiling level</p> <p>Material will be cut to fit and fastened as required</p> <p>OR</p> <p>Side of stud bays will be sealed with rigid material from bottom of dropped ceiling to top-plate</p> <p>OR</p> <p>Wall below openings will be dense packed</p> <p>OR</p> <p>Wall below openings will be bridged and sealed with SPF</p> <p>Seals will be used that prevent visible air movement using chemical smoke at 50 pascals of pressure difference</p>	Prevent air leakage from dropped ceiling to attic
PA WAP Guidance:	If area is significant (e.g. more than one room or an entire first floor), contact DCED for guidance.	

Title	Specification(s)	Objective(s)
3.1003.4c Support	<i>Support material</i> will be installed for spans wider than 24", except when <i>air barrier</i> material is rated to span greater distance under load (e.g., wind, insulation)	Ensure seal stays in place and does not sag



Before

Spans greater than 24 inches require additional bracing before capping



After

Support should prevent cap from sagging or moving

Tools:

1. Drill
2. Saw
3. Tape measure

Materials:

1. Lumber
2. Drywall
3. Fasteners



Create bracing to support spans larger than 24", either from above or below



When supporting from above, apply adhesive between drywall and bracing



Bracing can be screwed to drywall before capping chase



Ensure new bracing is secure by using screws to fasten to joist



Once chase is capped, it is now ready to be sealed along framing

Title	Specification(s)	Objective(s)
3.1003.4d Joint seal	<p>Continuous seal will be installed around seams, cracks, joints, edges, penetrations, and connections</p> <p>Pre-fabricated units may be used when meeting the desired outcome</p>	Provide airtight, durable seal that does not move, bend or sag



Before

Dropped soffits need to be capped and sealed to prevent leakage



After

No gaps should remain after spray foam is applied

Tools:

1. Spray foam gun
2. Caulk gun

Materials:

1. Caulk
2. Spray foam



1. Caulk surrounding surfaces before setting cap in place



2. Sealant should extend along surround joist and into seams at top plates



3. Once cap is set, apply sealant to remaining gaps and along all seams

Title	Specification(s)	Objective(s)
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



Before

Dropped soffits need to be capped and sealed to prevent leakage



After

No gaps should remain after sealant is applied along adjacent framing

Tools:

1. Spray foam gun
2. Caulk gun

Materials:

1. Caulk
2. Spray foam



1. Sealant should have been along all joists and adjacent framing before cap was set



2. Additional sealant should fill in all remaining gaps after cap has been set

3.1003.5 Dropped Ceiling with Light Boxes and Fixtures

Topic: Attics

Subtopic: Dropped Ceilings and Soffits

Desired Outcome: Sealed light boxes safely prevent air leakage and moisture movement between the attic and conditioned space

For supporting material, see [Calculation of the Infiltration Credit](#) and [Referenced Standards](#).

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 inches 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 inches clearance on all sides Top of rigid barrier enclosure will be sealed with non-insulating <i>rigid material</i> (e.g., gypsum or equivalent <i>perm rating</i> and R-value)	Prevent light fixture from overheating Bring light fixture inside of the <i>air barrier</i>

3.1003.6 Dropped Soffits

Topic: Attics

Subtopic: Dropped Ceilings and Soffits

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

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 <i>air barrier</i> across soffit openings



Before

Accessible drop soffits should be sealed to prevent heat gain/loss

Tools:

1. Measuring tape
2. Utility knife
3. Caulk gun
4. Spray foam gun
5. Saw
6. Drill



After

Completely sealed drop soffits and chases minimize heat transfer

Materials:

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

There is a variety of ways to seal soffits. Please examine 3.1003.6c and 3.1003.6d for more information.

Title	Specification(s)	Objective(s)
3.1003.6c Option 1: bring soffit inside (seal at top)	<p>Entire opening will be spanned with <i>rigid material</i> in line with the ceiling level</p> <p>Material will be cut to fit and fastened as required</p>	<p>Prevent air leakage from wall to attic</p> <p>Reduce opening to what can be sealed with sealant</p> <p>Ensure closure is permanent and supports any load (e.g., wind, insulation)</p> <p>Bring soffit into <i>thermal boundary</i></p>



Before

Standard soffits are often open to the attic and uninsulated



After

Rigid material encloses the soffit into the conditioned living space

Tools:

1. Drill/screwdriver
2. Caulk gun

Materials:

1. Drywall
2. Sealant



1. Soffits open to the attic need to be sealed to maintain air barrier



2. Apply sealant along top plates



3. Cap soffit with rigid material, such as drywall, cut to size



4. Fasten cap with screws to set sealant and create air barrier



5. Insulate over now-capped soffit

Title	Specification(s)	Objective(s)
3.1003.6d Option 2: leave soffit outside (seal at bottom or side)	<p>Each stud bay will be spanned with <i>rigid material</i> will be cut to fit and fastened as required</p> <p>OR</p> <p>Backing at each stud bay will be provided and will be sealed</p> <p>OR</p> <p>Side of stud bays will be sealed with <i>rigid material</i> from bottom of soffit to top-plate</p> <p>OR</p> <p>A sealed rigid barrier will be installed at all transitions</p>	<p>Prevent air leakage from wall to soffit</p> <p>Reduce opening to what can be sealed with sealant</p> <p>Ensure soffit is outside of the <i>thermal boundary</i></p>



Before

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

Tools:

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



After

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

Materials:

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

Title	Specification(s)	Objective(s)
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3.1003.6d Option 2: leave soffit outside (seal at bottom or side)



Clear work area of insulation and debris



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



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



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

<p>3.1003.6e Soffits containing non-IC rated recessed lights</p>	<p>Insulation will be kept at least 3" away from the top and side of any fixtures</p> <p>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</p> <p>Top of rigid barrier enclosure will be sealed with non-insulating <i>rigid material</i> (e.g., gypsum or equivalent <i>perm rating</i> and R-value)</p>	<p>Prevent light fixture from overheating</p> <p>Bring light fixture inside of the <i>air barrier</i></p>
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Subtopic 3.1004 Cathedralized Attic Ceilings

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

Topic: Attics

Subtopic: Cathedralized Attic Ceilings

Desired Outcome: Cathedralized attics sealed to prevent air leakage

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

Subtopic 3.1005 Other Ceiling Materials

3.1005.1 Tongue and Groove Ceilings

Topic: Attics

Subtopic: Other Ceiling Materials

Desired Outcome: Tongue and groove ceilings sealed to prevent air leakage and moisture movement between the attic and conditioned space

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

Topic 3.12 Windows and Doors

Subtopic 3.1201 Maintenance, Repair, and Sealing

3.1201.1 Double-Hung Wood Windows

Topic: Windows and Doors

Subtopic: Maintenance, Repair, and Sealing

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

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 <i>EPA's</i> Renovation, Repair and Painting (<i>RRP</i>) 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
PA WAP Guidance:	Refer to PA WAP Health and Safety Plan. Remember to document lead-safe work practices in the Client File (photos).	

Title	Specification(s)	Objective(s)
3.1201.1b Weather stripping	<p>Existing weather stripping and sash sealant will be removed</p> <p>Surface where the sill meets the sash will be cleaned</p> <p>Seal between the fixed components of the window (e.g., jambs, sill) will be continuous and complete while maintaining the operability of the window</p> <p>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</p>	<p>Form a complete seal from the outer edge of the sash to the jamb</p> <p>Maintain operability of the window</p>
3.1201.1c Sash locks	<p>Locks will be installed so that the rails of the upper and lower sashes are flush and in full contact</p> <p>No gaps will be visible between the two sashes</p> <p>Locks will be installed to achieve compression of the two sashes</p>	<p>Form a secure connection between the two sashes</p>
3.1201.1d Replacement sills	<p>Beveled sill will be flush with interior wall and sloped to the exterior</p> <p>Seams will be continuously and completely sealed with sealant to the jambs and to the frame</p> <p>Sill will be water-sealed and primed</p>	<p>Form a complete seal from the bottom of the lower sash to the sill</p> <p>Maintain operability of the window</p> <p>Allow for drainage to the exterior</p>



Before

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



After

Once repaired, this window is less leaky and better supported

Title	Specification(s)	Objective(s)
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3.1201.1d Replacement sills

Tools:

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

Materials:

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



Remove sill to determine full extent of rot and necessary repairs



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



Cut new materials flush to surrounding surfaces and pitch toward exterior



For exterior repairs, replace flashing



Set new sill, then replace and prime trim

3.1201.1e Sash replacement	<p>Lower sash will have the same bevel on the bottom rail as the sill</p> <p>Sash will be water-sealed and primed</p>	<p>Ensure sash remains in a fixed position when open or partially open</p> <p>Maintain operability of the window</p>
3.1201.1f Adjust stops	<p>Stops will be adjusted to eliminate visible gaps between the stops and the jamb while maintaining operability of the window</p>	<p>Form a complete seal between the jamb, sash, and stop</p> <p>Maintain operability of the window</p>
3.1201.1g Replace stops	<p>Stops will be installed to keep the window securely in place</p> <p>Stops will be adjusted to eliminate visible gaps between the stops and the jamb while maintaining operability of the window</p>	<p>Form a complete seal between the jamb, sash, and stop</p> <p>Maintain operability of the window</p>

3.1201.2 Single-Unit Window and Fixed Frame with Wood Sash

Topic: Windows and Doors

Subtopic: Maintenance, Repair, and Sealing

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

Title	Specification(s)	Objective(s)
3.1201.2a Lead paint assessment	<p>Presence of lead-based paint in pre-1978 homes will be assumed unless testing confirms otherwise</p> <p><i>EPA's RRP</i> 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</p>	Protect worker and occupant from potential lead hazards
PA WAP Guidance:	<p>Refer to PA WAP Health and Safety Plan.</p> <p>Remember to document lead-safe work practices in the Client File (photos).</p>	
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	<p>Details that reduce air <i>infiltration</i> 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)</p> <p>State Energy Conservation Code or local code requirements for air leakage should be met (whichever is more stringent)</p>	Reduce air <i>infiltration</i>
3.1201.2d Water infiltration	Details that reduce water <i>infiltration</i> will be repaired, replaced, or installed (e.g., replace missing glazing compound on sash, exterior caulking, exterior storm windows)	Reduce water <i>infiltration</i>
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

Desired Outcome: Doors operable and weather tight

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 <i>EPA's RRP</i> 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
PA WAP Guidance:	Refer to PA WAP Health and Safety Plan. Remember to document lead-safe work practices in the Client File (photos).	
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



Before

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

Tools:

1. Screwdriver
2. Planer



After

With proper adjustment, doors should hang true and minimize leakage

Materials:

1. Shims

Title	Specification(s)	Objective(s)
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3.1201.3b Door operation and fit



1. After examining how door hangs, remove door from hinges



2. Adjust hinge plates to bring door back into true



3. Adjust strike plate to allow for secure and smooth operation



4. Rehang door to verify adjustments worked and door operates smoothly

Title	Specification(s)	Objective(s)
3.1201.3c Air infiltration	Details that reduce air <i>infiltration</i> 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 <i>infiltration</i>



Before

Daylight visible around an exterior door indicates air infiltration



After

Weatherstripping and a door bottom minimize air infiltration around doors

Tools:

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

Materials:

1. Weatherstripping (Q-lan)
2. Door bottom
3. Fasteners
4. Caulk

Title	Specification(s)	Objective(s)
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3.1201.3c Air infiltration



Remove leaky door in order to affix door bottom



Measure and trim door, if necessary, to allow for door bottom



Trimming to allow for door bottom



Cut door bottom to width of door



Ensure door bottom fits snugly around door and fasten into place



Measure doorway for weatherstripping



Notch upper ends of side weatherstripping to allow for top piece



Weatherstripping should fit snugly into rabbit and against other pieces



Rehang door and verify fit, operation, and lack of air infiltration

Title	Specification(s)	Objective(s)
3.1201.3d Water infiltration	Details that reduce water <i>infiltration</i> will be repaired, replaced, sealed, or installed (e.g., adjust threshold, caulk jamb to threshold, caulk trim, flashing)	Reduce water <i>infiltration</i>



Before

Daylight visible under exterior doors indicate water can leak in



After

By adjusting the threshold and sealing along it, water should be kept out

Tools:

1. Caulk gun
2. Screwdriver
3. Pry bar

Materials:

1. Caulk sealant



Adjust threshold to minimize gap and keep water out



Caulk along threshold from inside and outside to prevent 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
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3.1201.4 Pocket Door

Topic: Windows and Doors

Subtopic: Maintenance, Repair, and Sealing

Desired Outcome: Pocket door sealed top and back to prevent leakage

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

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

Subtopic 3.1202 Repairing/Replacing Cracked and Broken Glass

3.1202.1 Fixed Frame with Wood Sash—Older House

Topic: Windows and Doors

Subtopic: Repairing/Replacing Cracked and Broken Glass

Desired Outcome: Glass complete and intact; improved energy efficiency performance of fenestration

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 <i>EPA's RRP</i> 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
PA WAP Guidance:	Refer to PA WAP Health and Safety Plan. Remember to document lead-safe work practices in the Client File (photos).	
3.1202.1b Broken glass removal	Putty and push points will be removed Broken or cracked glass will be removed	Safely remove old glass
PA WAP Guidance:	Wear proper Personal Protective Equipment (PPE).	



Tools:

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

Materials:

1. Tape

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

Before

Broken glass with failed repairs
needs to be replaced

Title	Specification(s)	Objective(s)
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3.1202.1b Broken glass removal



1. Always wear heavy work gloves when working with glass



2. Cut through caulk bead and glazing to ease removal



3. Remove old putty and glazing to expose metal points holding glass in place



4. With points and glass removed, measure opening for replacement pane



5. Cut replacement glass 1/8" smaller than measured opening

Title	Specification(s)	Objective(s)
3.1202.1c Sash preparation	Opening will be cleaned	Prepare opening for new glass

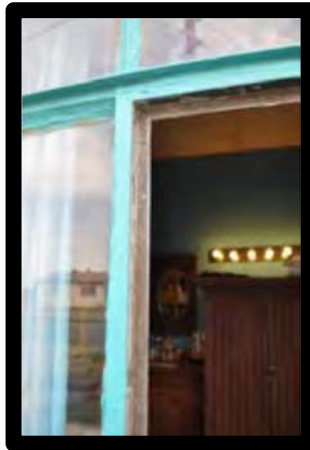


Before

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

Tools:

1. Chisel
2. Utility knife



In Progress

Mount new glass onto a clean surface

Materials:

1. Sand paper
2. Cleaning solution
3. Rags



1. Debris in the sash can cause new glass to seal improperly



2. Check closely to remove all pieces of broken glass and debris



3. With sash cleaned, glass will fit properly and glazing will seal

Title	Specification(s)	Objective(s)
3.1202.1d New glass installation	<p>Glass will be sized 1/8" to 3/16" smaller than opening to allow for movement of frame</p> <p>Safety glass will be installed in accordance with local codes</p> <p>Push points will be provided on each side to secure glass in frame</p> <p>Glazing compound will be added in accordance with manufacturer specifications</p>	<p>Ensure glazing compound will adhere to sash</p> <p>Install, seal, and secure new glass in place</p> <p>Allow glazing compound to harden to ensure secure installation</p>



Before

With sash prepared, installation of new pane can begin

Tools:

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



After

Replacement glass should be securely fixed with points and glazing

Materials:

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

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

Title	Specification(s)	Objective(s)
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3.1202.1d New glass installation



1. Always wear heavy work gloves when working with glass



2. With broken glass removed, measure opening for replacement glass



3. Cut replacement glass 1/8" smaller than measured opening



4. Use shims to center glass while installing push points



5. With push points in place, glaze to air seal new glass pane in sash



6. Secure pane in place with tape to hold until glazing sets

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

Topic: Windows and Doors

Subtopic: Repairing/Replacing Cracked and Broken Glass

Desired Outcome: Glass complete and intact; improved energy efficiency performance of fenestration

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 <i>EPA's RRP</i> 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
PA WAP Guidance:	Refer to PA WAP Health and Safety Plan. Remember to document lead-safe work practices in the Client File (photos).	

Title	Specification(s)	Objective(s)
3.1202.2b Broken glass removal	Window stops and damaged glass will be removed	Safely remove old glass
PA WAP Guidance:	Wear proper Personal Protective Equipment (PPE).	



Tools:

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

Materials:

1. Tape

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

Before

Broken glass with failed repairs needs to be replaced



1. Always wear heavy work gloves when working with glass



2. Cut through caulk bead and glazing to ease removal



3. Remove old putty and glazing to expose metal points holding glass in place



4. With points and glass removed, measure opening for replacement pane



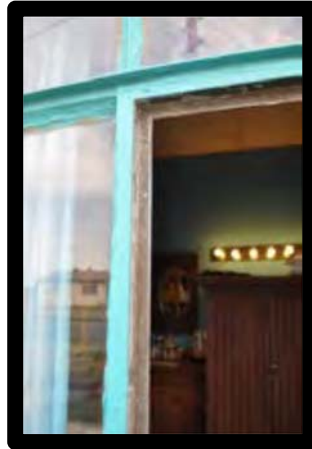
5. Cut replacement glass 1/8" smaller than measured opening

Title	Specification(s)	Objective(s)
3.1202.2c Opening preparation	<p>Opening will be cleaned</p> <p>Glazing tape will be removed or replaced</p>	<p>Prepare opening for new glass</p>



Before

Remove all debris, glazing tape, and glass from sash



In Progress

Sash surface must be clean before mounting

Tools:

1. Chisel
2. Utility knife

Materials:

1. Cleaning solution
2. Rags



- 1.** Debris in the sash can cause new glass to seal improperly



- 2.** Check closely to remove all pieces of broken glass and debris



- 3.** With sash cleaned, glass will fit properly and glazing will seal

Title	Specification(s)	Objective(s)
3.1202.2d New glass installation	<p>Replacement glass will be sized to original width, height, and depth</p> <p>Stops will be replaced or installed</p> <p>Wood stops will be sealed to glass with appropriate sealant</p> <p>Glass will be selected with comparable tint and coating (color and look)</p> <p>Tempered glass will be installed as required by local codes</p> <p>Glazing compound will be added in accordance with manufacturer specifications</p>	<p>Install, seal, and secure new glass in place</p> <p>Allow glazing compound to harden to ensure secure installation</p>



Before

With sash prepared, installation of new pane can begin

Tools:

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



After

Replacement glass should be securely fixed with points and glazing

Materials:

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

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

Title	Specification(s)	Objective(s)
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3.1202.1d New glass installation



1. Always wear heavy work gloves when working with glass



2. With broken glass removed, measure opening for replacement glass



3. Cut replacement glass 1/8" smaller than measured opening



4. With sash prepared, shim glass to center in opening and reinstall stops



5. Apply window glazing to air seal new pane

Subtopic 3.1203 Replacement

3.1203.1 Replacement Window in Existing Window Frame

Topic: Windows and Doors

Subtopic: Replacement

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

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 <i>EPA's RRP</i> 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
PA WAP Guidance:	Refer to PA WAP Health and Safety Plan. Remember to document lead-safe work practices in the Client File (photos).	

Title	Specification(s)	Objective(s)
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



Before

Wooden window still in opening



In Progress

Wood window with sashes removed before replacement

Tools:

1. Stiff bladed scraper or putty knife
2. Single-edge razor blade scraper



1. Wood double-hung window



2. Remove stop moulding (non-lead based paint). For lead based paint work requirements, visit <http://www2.epa.gov/lead>



3. Remove sashes and balances (tracks). Remove sash cords and pry pulleys out of the jamb in older units



4. Scrape loose paint and thoroughly clean opening.

Title	Specification(s)	Objective(s)
3.1203.1c Replacement window installation	Replacement window will be installed in accordance with manufacturer specifications, ensuring that the exterior stops are caulked	<p>Ensure replacement window operates properly</p> <p>Ensure replacement window has a weather tight fit</p>



Before

Window opening ready to receive replacement window



After

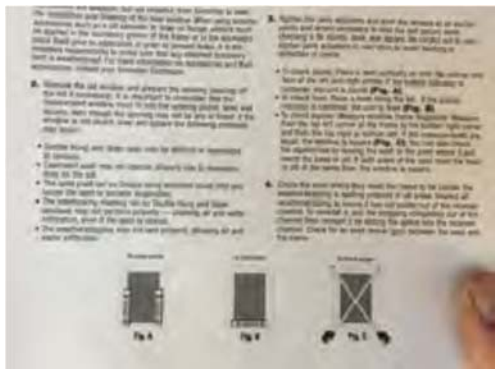
Replacement window installed, with stop moulding replaced and caulked

Tools:

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

Materials:

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



Follow manufacturer's installation instructions.

Title	Specification(s)	Objective(s)
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

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

Title	Specification(s)	Objective(s)
3.1203.2a Lead paint assessment	<p>Presence of lead-based paint in pre-1978 homes will be assumed unless testing confirms otherwise</p> <p>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</p>	Protect worker and occupant from potential lead hazards
PA WAP Guidance:	<p>Refer to PA WAP Health and Safety Plan.</p> <p>Remember to document lead-safe work practices in the Client File (photos).</p>	

Title	Specification(s)	Objective(s)
3.1203.2b Opening preparation	<p>Replacement window will be laid out with trim</p> <p>Exterior trim will be removed or exterior siding will be cut back to fit new window with trim</p> <p>Existing window will be removed</p> <p>Window opening will be flashed in accordance with accepted industry standards</p>	<p>Provide a clean and properly flashed opening for replacement window unit</p>



Before

Single pane window in newer home



In Progress

Window is removed to allow for replacement with double pane unit

Tools:

1. Pry bar
2. Utility knife
3. Drill

Materials:

1. Window and door flashing

Title	Specification(s)	Objective(s)
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3.1203.2b Opening preparation



1. Single pane window needs to be replaced with double pane



2. Cut through caulk at stops to break seal



3. Remove stops while attempting to keep damage to rough opening to minimum



4. Remove interior trim



5. Remove exterior trim



6. Remove exterior fasteners to free window



7. Remove window from rough opening



8. Clean rough opening to remove old caulk and debris



9. Install flashing along sides and bottom of rough opening

Title	Specification(s)	Objective(s)
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



Before

Single pane window is being removed



In Progress

Double-pane unit replaces previous single-pane one

Tools:

1. Tape measure
2. Utility knife



- 1.** Measure rough opening depth to determine best method of installation



- 2.** Clean old sealant off exterior surface to allow for flange installation



- 3.** Install unit following appropriate detail for rough opening and unit depth

Title	Specification(s)	Objective(s)
3.1203.2d Replacement window installation	<p>Replacement windows will be installed in accordance with manufacturer specifications and will be integrated with flashing</p> <p>Gaps between the new window and existing frame will be sealed with low-expanding foam</p>	<p>Ensure replacement window operates properly</p> <p>Ensure replacement window is weather tight</p>



Before

Single-pane window is being removed to install double-pane unit



After

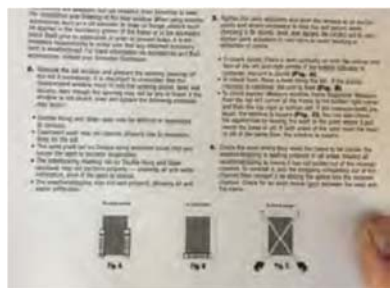
Double-pane unit installed with trim in place

Tools:

1. Utility knife
2. Spray foam gun
3. Drill
4. Hammer
5. Saw

Materials:

1. Fasteners
2. Flashing
3. Low-expansion spray foam
4. Backer rod
5. Primed trim



Follow manufacturer's installation instructions.

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

Topic 3.14 Basements and Crawl Spaces

Subtopic 3.1401 Basements Connected to Crawl Spaces

3.1401.1 Basements Connected to Crawl Spaces—Sealing and Insulating

Topic: Basements and Crawl Spaces

Subtopic: Basements Connected to Crawl Spaces

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

Title	Specification(s)	Objective(s)
3.1401.1a Conditioned basements with vented crawl spaces	Crawl space will be separated from the <i>conditioned basement</i> with a continuous <i>air barrier</i> , ground moisture barrier, and <i>thermal boundary</i>	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 <i>conditioned basement</i> with a continuous <i>air barrier</i> 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	<i>Vented crawl space</i> will be separated from the <i>unconditioned basement</i> with a continuous <i>air barrier</i> 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	<i>Unconditioned basement</i> will be treated as an extension of the <i>closed crawl space</i>	Create separation and define spaces Enable treatment of crawl spaces and basements by referenced specifications Increase house durability and energy efficiency

Subtopic 3.1402 Crawl Spaces

3.1402.1 Crawl Spaces—Sealing Floor Penetrations

Topic: Basements and Crawl Spaces

Subtopic: Crawl Spaces

Desired Outcome: Air leakage prevented and indoor air quality protected

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



Before

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



After

Gaps should be sealed to maintain air barrier

Tools:

1. Headlamp

Materials:

1. Backer rod
2. Sealant



1. Prepare work space by removing any insulation



2. Infill with backer rod



3. Apply appropriate caulking to ensure backing/infill does not move



4. Visually inspect to verify no gaps remain

Title	Specification(s)	Objective(s)
3.1402.1b Sealant selection	<p>Sealants will be used to fill holes no larger than recommended by manufacturer specifications</p> <p>Sealants will be compatible with their intended surfaces</p> <p>Sealants will allow for differential expansion and contraction between dissimilar materials</p> <p>Sealants will be continuous and meet fire barrier specifications, according to authority having jurisdiction</p>	<p>Create a permanent seal</p> <p>Ensure sealant meets or exceeds the performance characteristics of the surrounding materials</p>



Bad Practice

Avoid sealants that do not allow for expansion between dissimilar materials



Good Practice

Flexible sealants compensate for differential expansion and maintain a seal

Tools:

1. Caulk gun
2. Spray foam gun

Materials:

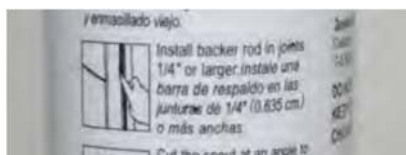
1. Caulk
2. Spray foam



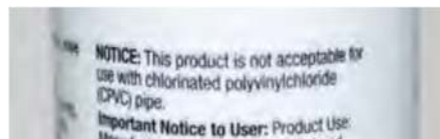
Caulking can be used to span gaps up to 1/4 inch



Spray foam can be used to span gaps up to 3 inches



Check manufacturer specifications to verify spanning capabilities



Also check manufacturer specs for incompatibility with intended surfaces

Title	Specification(s)	Objective(s)
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



Before

Gaps around floor penetrations allow air and moisture movement



After

Use non-combustible materials, like 26-gauge steel and high-temp caulk

Tools:

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

Materials:

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

Title	Specification(s)	Objective(s)
3.1402.1c High temperature application		



1. Prepare work area by removing any insulation and debris



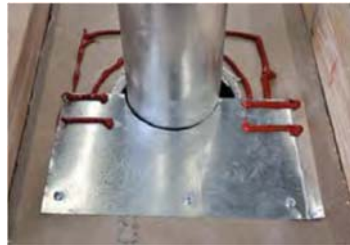
2. Use high-temperature caulking (600F min)



3. Apply first ring of caulking to match shape of opening



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



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



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

3.1402.2 Closed Crawl Spaces—Air Sealing Foundation Vents

Topic: Basements and Crawl Spaces

Subtopic: Crawl Spaces

Desired Outcome: Air and moisture penetration through the existing vent into the crawl space blocked

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

Title	Specification(s)	Objective(s)
3.1402.2a Vent closure	Vent opening will be permanently closed and sealed	Prevent air and moisture penetration
PA WAP Guidance:	Auditor must first evaluate the level of moisture in the crawl space. If high levels or concerns of moisture are present, do not close vents. Also, consult local code before sealing vents.	

3.1402.3 Closed Crawl Spaces—Air Sealing Exterior Wall

Topic: Basements and Crawl Spaces

Subtopic: Crawl Spaces

Desired Outcome: Well-sealed exterior wall prevents leakage and pests

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



Before

Light showing through penetration in exterior block wall



After

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

Tools:

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

Materials:

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



1. Measure holes to determine the best backing and fill strategy



2. In holes larger than 1/4 inch, wire mesh should be used for backing



3. Sprayfoam or caulk seal the hole

Title	Specification(s)	Objective(s)
3.1402.3b Pest exclusion	If penetration is greater than ¼ inches, caulking, steel wool, or other pest-proof material will be used to fill the penetration before sealing	Prevent pest entry



Before

For bigger holes, extra steps should be taken to keep out pests



After

Choose the backing and infill strategy that works best for the hole size

Tools:

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

Materials:

1. Caulk
2. Sprayfoam
3. Metal mesh
4. Rigid backing



- 1.** For holes larger than 1/4", rigid backing should be used to keep pests out



- 2.** Metal mesh or other rigid materials should be cut to fill the space



- 3.** Sprayfoam can be used to seal the hole and hold mesh in place

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

Topic: Basements and Crawl Spaces

Subtopic: Crawl Spaces

Desired Outcome: Well-sealed exterior wall prevents leakage and pests

Title	Specification(s)	Objective(s)
3.1402.4a Seal penetrations	<p>Penetrations will be sealed with a durable material, including the following:</p> <ul style="list-style-type: none">• Sealing rain screen to crawl space connection• Re-venting exterior weep holes with wicking rope <p>A minimum expected service life of 10 years will be ensured</p>	<p>Reduce moisture vapor and water from entering the crawl space through the rain screen</p> <p>Decrease probability of rot</p>
3.1402.4b Pest exclusion	<p>If penetration is greater than ¼", a pest-proof material will be used to fill the penetration before sealing</p>	<p>Prevent pest entry</p>

3.1402.5 Closed Crawl Spaces—Attached Crawl Spaces Under Unconditioned Spaces

Topic: Basements and Crawl Spaces

Subtopic: Crawl Spaces

Desired Outcome: Closed, attached crawl spaces sealed but accessible

For supporting material, see [Calculation of the Infiltration Credit](#) and [Referenced Standards](#).

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

Subtopic 3.1488 Special Considerations

3.1488.1 Skirting Post and Pier Foundations

Topic: Basements and Crawl Spaces

Subtopic: Special Considerations

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

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
PA WAP Guidance:	This applies only to repair of existing skirting. New skirting installation is not allowable in PA as an ECM.	
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

Topic 3.15 Attached Garages

Subtopic 3.1501 Garage Openings

3.1501.1 Penetrations, Cracks, and Doors Between Garage and House

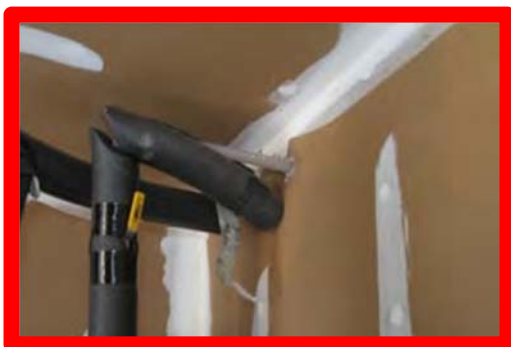
Topic: Attached Garages

Subtopic: Garage Openings

Desired Outcome: Openings from garage sealed to prevent leakage

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

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



Before

Penetrations between the garage and house can leak hazardous fumes



After

Seal penetrations to minimize risks and air leakage

Materials:

1. Backer Rod
2. Caulk
3. Spray foam

Title	Specification(s)	Objective(s)
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



Before

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



After

Sealed ductwork connections help prevent leakage

Materials:

1. Mesh tape
2. Mastic



Prepare work area by assessing any safety concerns



Wrap joint with fiberglass mesh tape



Apply UL 181 mastic to seal joint

Title	Specification(s)	Objective(s)
3.1501.1c Cracks	<p>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</p> <p>All cracks in ceiling surfaces will be sealed</p>	Prevent air leakage and pollutant entry



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



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

- Materials:**
1. Sprayfoam
 2. Fire-block caulk



Determine which walls are shared between garage and living space



Inspect wall and ceiling for cracks and penetrations



Clear work area of obstacles and debris



Apply appropriate sealant dependent upon size of crack and location



Ensure sealant does not decrease wall's fire resistance

Title	Specification(s)	Objective(s)
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



Before

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



After

With proper adjustment, doors should hang true and minimize leakage

Tools:

1. Caulk gun
2. Screwdriver
3. Utility knife
4. Hacksaw
5. Saw
6. Tape measure
7. Drill
8. Planer

Materials:

1. Weatherstripping (Q-lan)
2. Door sweep
3. Caulk
4. Fasteners



Remove door for access to work space and to install sweep



Measure for weatherstripping around door



Install weatherstripping into rabbit around door



Corners of weatherstripping should be snug and secure



Adjust threshold to minimize contaminant and water infiltration



Caulk along threshold to minimize water and contaminant infiltration



Cut door sweep to width of the door

Ensure door sweep fits tightly against bottom of door and fasten in place



Rehang door to verify snug fit and smooth operation

Title	Specification(s)	Objective(s)
3.1501.1e Glass	Broken glass panes in doors will be replaced, pointed, and glazed where needed	Prevent air leakage and pollutant entry



Before

Broken glass in exterior and garage doors allows for leakage.



After

With new glass in place, take care to tightly seal and replace stops

Tools:

1. Hammer
2. Pry bar
3. Caulk gun
4. Tape measure

Materials:

1. Brads
2. Caulk
3. Glazing
4. New glass cut to size of rough opening



Remove stops, taking care not to damage them



Remove broken glass and clean old sealant and glazing from rough



Measure rough opening and cut new glass to size



Apply sealant to rough opening and place new glass



Seal glass into place from inside as well to ensure no air infiltration



Replace stops and rehang door

Title	Specification(s)	Objective(s)
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



Best Practice

Carbon monoxide alarms should be installed throughout the house



Best Practice

Occupants should be alerted to CO alarm locations and maintenance

CO alarms should be installed one per floor and near sleeping areas.

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
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Unsafe

Communicate importance of never running vehicles in a closed garage



Unsafe

Occupants should not light combustibles inside garages



Best Practice

Occupants should be alerted to CO alarm locations and maintenance. Speak with occupant about hazards of using gas appliances in the garage

Topic 3.16 Ducts

Subtopic 3.1601 Duct Preparation

3.1601.1 Preparation and Mechanical Fastening

Topic: Ducts

Subtopic: Duct Preparation

Desired Outcome: Ducts and plenums properly fastened to prevent leakage

For supporting material, see [Calculation of the Infiltration Credit](#) and [Referenced Standards](#).

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 well as 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
PA WAP Guidance:	If asbestos is suspected, refer to PA WAP Health and Safety Plan.	
3.1601.1b Metal to metal	Round ducts will be mechanically fastened to maintain alignment Other shaped ducts will be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems, or tapes	Ensure durable joints
3.1601.1c Flex to metal	Joints will be fastened with tie bands using a <i>tie band</i> 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 <i>IRC</i> 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 <i>IRC</i> Chapter 16, 2012 <i>IRC</i> N1103.2, and applicable local code	Ensure durable joints

3.1601.2 Duct Preparation for SPF Application

Topic: Ducts

Subtopic: Duct Preparation

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

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

Title	Specification(s)	Objective(s)
3.1601.2a Inspection	<p>All exposed ductwork in unconditioned spaces (e.g., attics, basements, crawl spaces) will be inspected</p> <p>Broken joints or large cracks, gaps, or holes will be identified</p> <p>Type of ductwork (e.g., metal, duct board, flex duct) will be identified</p> <p>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</p> <p>If asbestos insulation was used, it will not be disturbed; consult with an asbestos abatement expert for removal</p> <p>Loose fitting or damaged fiberglass or stone wool insulation will be removed using proper safety equipment</p> <p>Necessary clearances for installation of SPF will be ensured</p>	<p>Identify damaged ductwork in need of repair</p> <p>Identify type and R-value of existing insulation</p>
PA WAP Guidance:	If asbestos is found, refer to the PA WAP Health & Safety Plan.	
3.1601.2b Repair	<p>Broken or missing ductwork will be repaired or replaced</p> <p>All cracks, gaps, or holes greater than ¼" will be taped or sealed as feasible</p> <p>Dust, dirt, and grease will be removed from exterior surfaces of ducts</p>	<p>Cover openings in ducts to prevent SPF from entering the interior of the duct</p> <p>Ensure surfaces of duct are clean to promote proper adhesion of SPF</p>

3.1601.3 Support

Topic: Ducts

Subtopic: Duct Preparation

Desired Outcome: Ducts and plenums properly supported

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

Title	Specification(s)	Objective(s)
3.1601.3a Support (applies to all duct types)	<p>Flexible and duct board ducts and plenums will be supported every 4' using a minimum of 1 1/2" wide material</p> <p>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</p> <p>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</p>	Eliminate falling and sagging



Before

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

Tools:

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



After

Properly supported ducts minimize heat loss and maximize duct run

Materials:

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

Title	Specification(s)	Objective(s)
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3.1601.3a Support (applies to all duct types)



BAD: Make sure supports DO NOT compress insulation or duct



Flex ducts should have supports no less than every 4 feet



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



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



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



Metal wire should be at least 12 gauge and galvanized

Subtopic 3.1602 Duct Sealing

3.1602.1 Air Sealing Duct System

Topic: Ducts

Subtopic: Duct Sealing

Desired Outcome: Ducts and plenums sealed to prevent leakage

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

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 <i>IRC</i> Chapter 16	Ensure effectiveness of air sealing system
3.1602.1b New component to existing component	<p>Seams, cracks, joints, holes, and penetrations less than 1/4" will be sealed using fiberglass mesh and mastic</p> <p>Mastic alone will be acceptable for holes less than 1/4" that are more than 10' from air handler</p> <p>Seams, cracks, joints, holes, and penetrations between 1/4" and 3/4" will be sealed in two stages:</p> <ul style="list-style-type: none">• 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	<p>Eliminate air leakage into or out of ducts and plenums</p> <p>Ensure adhesion of primary seal (mastic and fiberglass mesh) to the duct</p> <p>Reinforce seal</p> <p>Support mastic and fiberglass mesh during curing</p>

Title	Specification(s)	Objective(s)
3.1602.1c Existing component to existing component	<p>Fiberglass mesh and mastic will overlap temporary tape by at least 1" on all sides</p> <p>Fiberglass mesh and mastic will become the primary seal</p> <p>Seams, cracks, joints, holes, and penetrations larger than 3/4" will be repaired using rigid duct material</p> <p>Fiberglass mesh and mastic will overlap repair joint by at least 1" on all sides</p> <p>Fiberglass mesh and mastic will be the primary seal</p>	<p>Eliminate air leakage into or out of ducts and plenums</p> <p>Ensure adhesion of primary seal (fiberglass mesh and mastic) to the duct</p> <p>Reinforce seal</p> <p>Support fiberglass mesh and mastic during curing</p>



Before

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



After

Sealed ductwork connections help prevent leakage

Materials:

1. Mesh tape
2. Mastic



Prepare work area by assessing any safety concerns



Wrap joint with fiberglass mesh tape



Apply UL 181 mastic to seal joint

3.1602.2 Duct Spray Polyurethane Foam (SPF) Installation

Topic: Ducts

Subtopic: Duct Sealing

Desired Outcome: Exposed ductwork in unconditioned spaces insulated and sealed

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

Title	Specification(s)	Objective(s)
3.1602.2a Installation	<p>Insulation will be installed according to manufacturer specifications and all provisions of the 2012 <i>IRC</i></p> <p><i>SPF</i> will be applied to desired thickness, using pass thickness maximum as indicated by manufacturer</p> <p>Sufficient insulation will be applied to all joints and around all penetrations to the conditioned space through walls, floors, and ceilings</p> <p><i>SPF</i> 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 <i>IRC</i> and local codes</p> <p>If ducts are used for air-conditioning, an appropriate <i>vapor retarder</i> will be applied on the <i>SPF</i> if open-cell <i>SPF</i> used</p> <p>If 2" or more of closed-cell <i>SPF</i> is used, follow manufacturer specification to determine if additional <i>vapor retarder</i> is needed</p> <p>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</p> <p>The foam plastic will be protected with an <i>ignition barrier</i></p>	<p>Insulate and seal all exposed ductwork in unconditioned spaces</p> <p>Manage moisture condensation on ductwork that carry cooled air in warm, moist climates</p> <p>Provide adequate fire protection for exposed <i>SPF</i></p>

3.1602.3 Proprietary Spray Application

Topic: Ducts

Subtopic: Duct Sealing

Desired Outcome: Ducts and plenums sealed to prevent leakage

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

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

Desired Outcome: Ducts and plenums sealed to prevent leakage

For supporting material, see [Calculation of the Infiltration Credit](#) and [Referenced Standards](#).

Title	Specification(s)	Objective(s)
3.1602.4a Duct boot to interior surface	All gaps between boot and interior surface that defines conditioned space will be air sealed Gypsum edge will be wetted before applying water-based sealant Sealants will be continuous and be in accordance with 2012 IRC R302.9	Prevent air leakage Prevent a fire hazard



Before

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



After

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

Title	Specification(s)	Objective(s)
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3.1602.4a Duct boot to interior surface

Tools:

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

Materials:

1. Mesh tape
2. Mastic



1. Remove grill to expose duct boot and gaps



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



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



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



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

Title	Specification(s)	Objective(s)
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



Before

Locate unsealed ducts constructed from building cavities

Tools:

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



After

Return plenum lined with fiberglass duct board and sealed with mastic

Materials:

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

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

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

From NFPA 90B 4.3.1.1: "Duct coverings, duct linings, and tapes used in duct systems shall have a maximum flame spread index of 25 without evidence of continued progressive combustion and a maximum smoke developed index of 50 when tested in accordance with ASTM E 84 or ANSI/UL 723..."

Title	Specification(s)	Objective(s)
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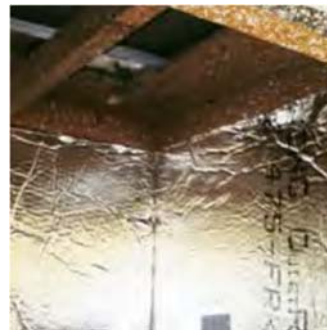
3.1602.4b Wooden plenums and building cavities



1. Identify building cavities used as ducts



2. Seal penetrations around AC lineset and wiring



3. Cut and install appropriate board material to create an airtight duct



4. Seal all seams and joints with duct mastic

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
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Before

Unnecessary holes in the air handler cabinet need to be sealed



After

Use removable foil tape to seal holes

Materials:

1. Foil tape

Title	Specification(s)	Objective(s)
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3.1602.4c Air handler cabinet



1. Unnecessary holes in the air handles cabinet should be sealed

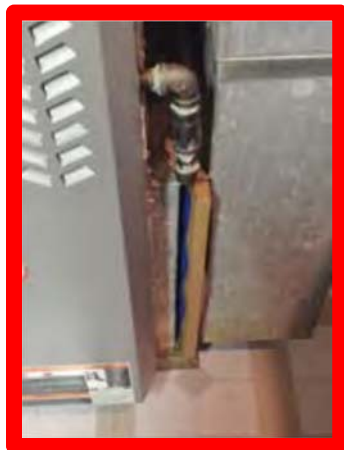


2. Removable foil tape should be used to seal



3. Fully cover holes with tape to seal completely

3.1602.4d Filter slot	A pre-manufactured or site manufactured durable filter slot cover will be installed	Reduce air leakage while maintaining accessibility
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Before

Uncovered filter slots are a point of leakage



After

Filter slots should be covered

3.1602.5 Return—Framed Platform

Topic: Ducts

Subtopic: Duct Sealing

Desired Outcome: The return duct installed to prevent air leakage

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

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



Before

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



After

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

Tools:

1. Shop vacuum

3.1602.5b Infill and backing	<p>Backing or infill will be provided as needed to meet the specific characteristics of the selected material and the characteristics of the open space</p> <p>Backing or infill will not bend, sag, or move once installed</p> <p>Material will be rated for use in return duct systems</p>	<p>Minimize hole size to ensure successful use of sealant</p> <p>Ensure closure is permanent and supports any load (e.g., return air pressure)</p> <p>Ensure sealant does not fall out</p>
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Before

Leakage from air return into wall cavities should be eliminated



In Progress

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

Title	Specification(s)	Objective(s)
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3.1602.5b Infill and backing

Tools:

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

Materials:

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



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

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
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Best Practice

Sealants, like mesh and UL 181 mastic, meet IRC, ASTM, and UL specs

Tools:

1. Caulk gun
2. Utility knife
3. Taping knife



Best Practice

Caulk sealants will be continuous

Materials:

1. Fiberglass mesh
2. Siliconized caulk
3. UL 181 mastic

Paraphrased from 2012 IRC R302.9: Wall and ceiling finishes will have a flame spread index of 200 or less and a smoke-developed index of 450 or less

3.1602.6 Capping Dual-Cooling Up-Ducts

PA WAP Guidance: 3.1602.6 Capping Dual-Cooling Up-Ducts	Dual-Cooling Up-Ducts (evaporative coolers) are not an allowable measure in PA. Do not apply SWS 3.1602.6.
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3.1602.7 Return and Supply Plenums in Basements and Crawl Spaces

Topic: Ducts

Subtopic: Duct Sealing

Desired Outcome: Connections between the crawl space/ [unconditioned basement](#) and living space eliminated to improve indoor air quality ([IAQ](#)) and efficiency of the distribution system

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	Eliminate connection between the crawl space/ unconditioned basement and living space
3.1602.7b Return plenums	Basements and crawl spaces that are used as heating and cooling return plenums will not be allowed	Eliminate connection between the crawl space/ unconditioned basement and living space

Chapter 4: Insulation

Insulation materials installed using PA WAP funds must meet the standards for conformance based on Appendix A of 10 CFR, part 440.

When insulation is called for in the standardized whole-house audit, insulation levels must adhere to the current adopted IRC energy code.

All manufactured housing belly and ceiling insulation material must be fiberglass insulation.

- Referenced SWS: 4.1303.1 Insulation of Floor Cavity with Blown Material

Spray Polyurethane Foam (SPF) insulation will be installed in accordance with manufacturer specifications. Agencies must follow OSHA Confined Space safety requirements (OSHA 29 CFR 1926.1201).

Adhere to the air insulation-related topics referenced in the *DCED Directive: Health and Safety*.

Insulation Certificate

As per the Code of Federal Regulations (16 CFR 460.17), subgrantees must provide clients with “a contract or receipt for the insulation” installed. For the purposes of this section, that “contract or receipt” will be referred to as a “certificate.”

A copy of the insulation certificate must be posted in the client’s home at the location where it was installed or posted according to the 2012 IRC section N1101.16 (R401.3), paraphrased: on or in the electrical distribution panel so that it does not cover or obstruct the visibility of the circuit directory label, service disconnect label or other required labels.

A copy of the certificate must also be kept in the Client File. Agencies are recommended to note in the Client File where the insulation certificate was posted in the client’s home.

The certificate must be signed and dated by the Crew Chief. For all insulation, the certificate must show the insulation’s coverage area, initial installed thickness, and R-value of the installed insulation. For loose-fill insulation only, in addition to the requirements above, the certificate must also show the insulation’s minimum settled thickness, and the number of bags used.

If insulation is installed in more than one part of the dwelling unit, the data for each part may be placed on the same certificate, as long as the coverage areas or R-values for different parts of the dwelling unit are not added together.

Crosswalk of Insulation SWS with the ANSI/BPI 1100 Energy Auditing Standard

The SWS for Health and Safety will apply to Auditors as they follow the ANSI-BPI-1100-T-2014 Home Energy Auditing Standard sections 10 and 11.

4. Insulation SWS

Topic 4.10 Attics

Subtopic 4.1001 General Preparation

4.1001.1 Non-Insulation Contact (IC) Recessed Light

Topic: Attics

Subtopic: General Preparation

Desired Outcome: Ensure safety from fire and prevent air leakage

For supporting material, see [Referenced Standards](#).

Title	Specification(s)	Objective(s)
4.1001.1a Air barrier system	<p>A fire-rated <i>air barrier</i> system (i.e., equivalent to 5/8 fire code gypsum wallboard) will be used to separate non-<i>IC</i> rated recessed lights from insulation, using one of the methods below:</p> <p>A fire-rated airtight closure taller than surrounding attic insulation will be placed over non- <i>IC</i> rated recessed lights</p> <p>OR</p> <p>The non- <i>IC</i> rated light fixture will be replaced with an airtight and <i>IC</i> - rated fixture</p> <p>OR</p> <p>The fixture(s) may be replaced with surface mounted fixture and opening sealed</p> <p>OR</p> <p>Air sealing measures as approved by the authority having jurisdiction</p>	<p>Prevent a fire hazard</p> <p>Prevent air leakage through fixture</p>
PA WAP Guidance:	<p>If building an air tight box around a non-IC rated recessed fixture, be sure to consult the local authority having jurisdiction (LAHJ). It is recommended to replace the fixture with an enclosed surface mount if possible.</p>	

Title	Specification(s)	Objective(s)
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4.1001.1a Air barrier system



Before

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

Tools:

1. Utility knife
2. Tape measure

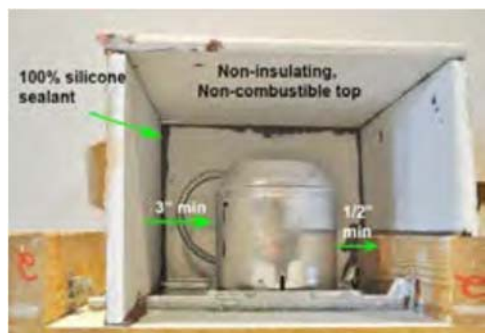


After

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

Materials:

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



Box should be constructed with clearances in mind



Sealed box should be constructed of fire-rated drywall



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

Title	Specification(s)	Objective(s)
4.1001.1b Enclosure top	<p>The top-fire rated enclosure material will have an R-value of 0.5 or less</p> <p>The top of the enclosure will be left free of insulation</p>	Prevent heat build up



Before

Non-IC rated recessed lights create excess heat and are a fire risk

Tools:

1. Utility knife
2. Caulk gun



After

Once dammed from insulation, it should still not have insulation on top

Materials:

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

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
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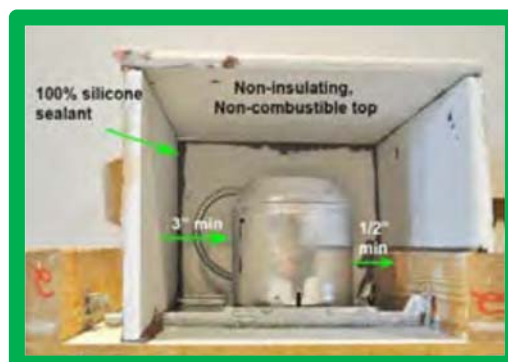


Before

Non-IC rated recessed lights produce excess heat and are a fire risk

Tools:

1. Utility knife
2. Tape measure
3. Caulk gun



After

A 3 inch clearance should be kept from boxing materials

Materials:

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

Title	Specification(s)	Objective(s)
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

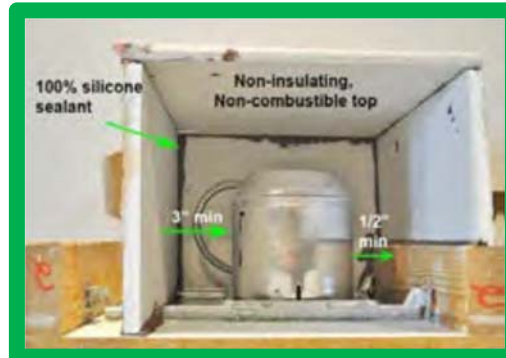


Before

Non-IC rated recessed light fixtures produce excess heat and are a fire risk

Tools:

1. Caulk gun
2. Spray foam gun
3. Putty knife



After

A 3 inch clearance should be kept from boxing materials

Materials:

1. Fire-rated silicone caulk
2. UL-181 mastic
3. Spray foam

4.1001.2 Knob and Tube Wiring

Topic: Attics

Subtopic: General Preparation

Desired Outcome: Insulation kept away from contact with live wiring

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

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

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



Unsafe

Identify knob and tube wiring in homes to insulate properly and safely. Distinctive "knobs" are highlighted. This wiring can be a safety hazard.



Knob and tube wiring should be identified before work begins

Title	Specification(s)	Objective(s)
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



Unsafe

Knob & tube wiring needs to be tested to determine if still live. This tester shows that Red=live. Refer to tester manufacturer instructions when testing.

Tools:

1. Non-contact wire tester



Safe

Live wiring should be dammed or professionally disabled before insulating

Title	Specification(s)	Objective(s)
4.1001.2c Isolate or replace	<p>Live knob and tube will not be covered or surrounded; required by the National Electrical Code (NEC) or authority having jurisdiction</p> <p>A licensed electrical contractor will inspect and certify wiring to be safe and place a warning at all entries to the attic about the presence of knob and tube wiring</p> <p>A dam that does not cover the top will be created to separate insulation from the wire path</p> <p>OR</p> <p>Knob and tube wiring will be replaced with new appropriate wiring by a licensed electrician in accordance with local codes</p> <p>Remaining knob and tube wiring will be rendered inoperable by licensed electrician in accordance with local codes</p>	<p>Ensure work can be completed safely</p> <p>Protect occupant and house</p> <p>Ensure future work can be done safely</p> <p>Prevent the overheating of the wiring</p>
PA WAP Guidance:	There is no statewide license requirement in PA; however, a qualified person and a 3rd party inspection is required in PA. The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.	



Before

Knob & tube wiring radiates heat and cannot be insulated over

Tools:

1. Non-contact wire tester
2. Drywall
3. Plywood
4. Saw
5. Drill
6. Tape measure



After

Before insulation, wiring should be dammed or disabled and replaced

Materials:

1. Fasteners
2. Romex as needed

NEC guidelines and local jurisdictions often closely prescribe the treatment of knob & tube wiring. Check your local codes..

Title	Specification(s)	Objective(s)
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4.1001.2c Isolate or replace



If electrician determines wiring is safe and keeps it active, isolate wires



To isolate, dams higher than intended insulation depth should be installed



Warning of knob & tube should be posted at all entrances to related spaces



Warning sign should encourage the use of certified electrician for repairs



Some jurisdictions require warning sign in Spanish as well



If knob & tube can be replaced, all existing knob & tube should be disabled



Many electricians will removed exposed wires to prevent reactivation



Modern wiring should replace all knob & tube

4.1001.3 Fireplace Chimney and Combustion Flue Vents

Topic: Attics

Subtopic: General Preparation

Desired Outcome: Combustible materials kept away from combustion sources

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

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



Before

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

Tools:

1. Metal snips
2. Caulk gun
3. Fasteners



After

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

Materials:

1. 26-gauge steel sheeting
2. High temperature caulk
3. Backer rod

Title	Specification(s)	Objective(s)
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4.1001.3a Verify attic prep



Gaps around flues and penetrations need to be sealed before insulating



Use high-temperature caulking (600F min) for flues and chimneys



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



Only construct dam after sealing has been completed properly



Dammed chimneys, flues, and light fixtures prevent fires

4.1001.3b Required clearance	<p>A rigid dam having a height greater than the insulation to be installed will be constructed to ensure a 3" clearance between combustion flue vent and dam</p> <p>Chimney vents will have an airspace clearance to combustibles in accordance with 2012 IRC M1801.3.4</p>	<p>Ensure dam material does not bend, move, or sag</p> <p>Prevent a fire hazard</p>
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Before

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

Tools:

1. Metal snips



After

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

Materials:

1. 26-gauge steel sheeting
2. Fasteners

Title	Specification(s)	Objective(s)
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



Before

Insulation is not held back by dams around flues, chimneys, and light fixtures



After

Clear dams of any loose insulation in order to minimize risk of fire

4.1001.3d Occupant education	Documentation of material and R-value will be provided to occupant	Provide occupant with documentation of installation
PA WAP Guidance:	See PA SWS Field Manual, Chapter 4: Insulation, section on Insulation Certificate for PA WAP guidance	



Best Practice

Provide occupant with documentation of and about insulation installed



Communicate professionally with occupant to provide information and support

Documentation should include insulation material and r-value



4.1001.4 Vented Eave or Soffit Baffles

Topic: Attics

Subtopic: General Preparation

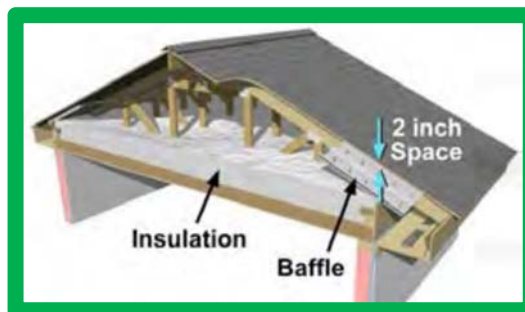
Desired Outcome: Attic ventilation meets code requirements and insulation is protected from wind washing

Title	Specification(s)	Objective(s)
4.1001.4a Installation	<p>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</p> <p>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</p> <p>Installation will allow for the highest possible R-value above the top plate of the exterior wall</p>	<p>Ensure insulation R-value is not reduced</p> <p>Maintain attic ventilation</p>



Before

Insulation should not block vented eaves



After

Baffles installed in vented attics to allow air flow past insulation

Tools:

1. Stapler

Materials:

1. Baffles
2. Staples



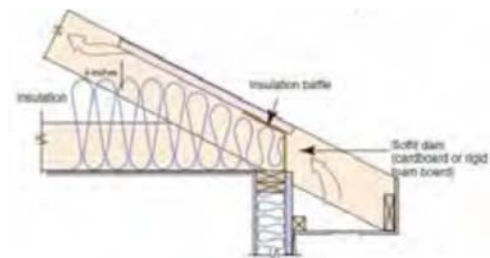
Allow a standard two inch gap for air flow through eave



Baffles should be securely fastened to prevent movement over time



Once baffles are properly installed, insulation can be placed against them



Baffles also hold insulation from falling into eave

4.1001.5 Dense Pack Preparation

Topic: Attics

Subtopic: General Preparation

Desired Outcome: Proper material density achieved safely and cleanly

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

4.1001.6 Unvented Roof Deck—Preparation for Spray Polyurethane Foam

Topic: Attics

Subtopic: General Preparation

Desired Outcome: Backstop provided to prevent [SPF](#) from entering soffit areas

For supporting material, see [Referenced Standards](#) and [General Information on Spray Polyurethane Foam \(SPF\)](#).

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

Desired Outcome: Backstop or substrate provided to prevent [SPF](#) from entering soffit areas while ensuring required attic ventilation is provided

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

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

Subtopic 4.1002 Above Roof Deck Insulation

4.1002.1 Above Roof Deck Insulation: Preparation

Topic: Attics

Subtopic: Above Roof Deck Insulation

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

Title	Specification(s)	Objective(s)
4.1002.1a 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 Above Deck Roof Deck Insulation: Installation

Topic: Attics

Subtopic: Above Roof Deck Insulation

Desired Outcome: Properly installed roof deck insulation

Title	Specification(s)	Objective(s)
4.1002.2a Sealing	Holes, gaps, and penetrations in existing roof deck will be sealed	Prevent air leaks
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	A dated receipt signed by the installer will be provided that includes: <ul style="list-style-type: none">• Insulation type• Coverage area• R-value• Installed thickness and settled thickness (settled thickness required for loose-fill only)• Number of bags installed in accordance with manufacturer specifications (for loose-fill only)	Document job completion to contract specifications Confirm amount of insulation installed Comply with 16 CFR 460.17
PA WAP Guidance:	See PA SWS Field Manual, Chapter 4: Insulation, section on Insulation Certificate for PA WAP guidance	

Subtopic 4.1003 Attic Ceilings

4.1003.1 Pitched/Vaulted/Cathedralized Ceilings—Loose Fill Over

Topic: Attics

Subtopic: Attic Ceilings

Desired Outcome: Reduce the rate of heat transfer through cathedral or [vaulted ceiling](#)

For supporting material, see [Calculation of the Infiltration Credit](#) and [Referenced Standards](#).

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

Title	Specification(s)	Objective(s)
4.1003.1d Occupant education	<p>A dated receipt signed by the installer will be provided that includes:</p> <ul style="list-style-type: none"> • Insulation type • Coverage area • R-value • Installed thickness and minimum settled thickness • Number of bags installed in accordance with manufacturer specifications 	<p>Document job completion to contract specifications</p> <p>Confirm amount of insulation installed</p> <p>Ensure ability to match bags required for total area completed</p> <p>Comply with 16 CFR 460.17</p>
PA WAP Guidance:	See PA SWS Field Manual, Chapter 4: Insulation, section on Insulation Certificate for PA WAP guidance	

4.1003.2 Pitched/Vaulted/Cathedralized Ceilings—Dense Pack Over

Topic: Attics

Subtopic: Attic Ceilings

Desired Outcome: Insulation reduces heat transfer through ceiling and closed attic sections as well as framing cavities inaccessible to other treatments

For supporting material, see [Calculation of the Infiltration Credit](#) and [Referenced Standards](#).

Title	Specification(s)	Objective(s)
4.1003.2a Fill slant ceilings	<p>Using fill tube, 100% of each cavity will be filled to a consistent density:</p> <ul style="list-style-type: none"> 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 per manufacturer's recommendations <p>The number of bags installed will be confirmed and will match the number required on the coverage chart</p> <p>Insulation will be verified to prevent visible air movement using chemical smoke at 50 pascals of pressure difference</p>	<p>Ensure complete and consistent coverage throughout ceiling plane</p> <p>Eliminate voids and settling</p> <p>Minimize framing cavity air flows</p>
4.1003.2b Onsite documentation	<p>A dated receipt signed by the installer will be provided that includes:</p> <ul style="list-style-type: none"> Coverage area Thickness R-value 	<p>Document job completion to contract specifications</p> <p>Confirm amount of insulation installed</p> <p>Comply with 16 CFR 460.17</p>
PA WAP Guidance:	See PA SWS Field Manual, Chapter 4: Insulation, section on Insulation Certificate for PA WAP guidance	

4.1003.3 Unvented Flat Roof with Existing Insulation

Topic: Attics

Subtopic: Attic Ceilings

Desired Outcome: Insulation reduces heat flow through unvented roof

Title	Specification(s)	Objective(s)
4.1003.3a Ventilation	Code compliant ventilation will be installed before insulation	Reduce possibility of moisture issues



Before

Unvented flat roofs should have venting installed



After

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

Tools:

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

Materials:

1. Metal lath
2. Stucco

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
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Before

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



In Progress

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

Tools:

1. Insulation machine

Materials:

1. Loose fillable or dense packable insulation

Title	Specification(s)	Objective(s)
4.1003.3c Occupant education	<p>A dated receipt signed by the installer will be provided that includes:</p> <ul style="list-style-type: none"> • Insulation type • Coverage area • R-value • Installed thickness and minimum settled thickness • Number of bags installed in accordance with manufacturer specifications 	<p>Document job completion to contract specifications</p> <p>Confirm amount of insulation installed</p> <p>Ensure ability to match bags required for total area completed</p> <p>Comply with 16 CFR 460.17</p>
PA WAP Guidance:	See PA SWS Field Manual, Chapter 4: Insulation, section on Insulation Certificate for PA WAP guidance	



Best Practice

Provide occupant with documentation of and about insulation installed



Communicate professionally with occupant to provide information and support



Documentation should include insulation material and r-value

4.1003.4 Cape Cod Side Attic Roof—Dense Pack Installation

Topic: Attics

Subtopic: Attic Ceilings

Desired Outcome: Consistent, uniform [thermal boundary](#) between conditioned and unconditioned space

For supporting material, see [Calculation of the Infiltration Credit](#) and [Referenced Standards](#).

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 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	A dated receipt signed by the installer will be provided that includes: <ul style="list-style-type: none">• Insulation type• Coverage area• R-value• Installed thickness and minimum settled thickness• Number of bags installed in accordance with manufacturer specifications	Document job completion to contract specifications Confirm amount of insulation installed Ensure ability to match bags required for total area completed Comply with 16 CFR 460.17
PA WAP Guidance:	See PA SWS Field Manual, Chapter 4: Insulation, section on Insulation Certificate for PA WAP guidance	
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

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

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

Title	Specification(s)	Objective(s)
4.1003.5a Installation	<p>Insulation will be installed to prescribed R-value in accordance with manufacturer specifications</p> <p><i>SPF</i> will be applied to desired thickness, using pass thickness maximum as indicated by manufacturer, onto roof sheathing between rafters or trusses</p> <p>When desired, underside of rafters or trusses will be covered with <i>SPF</i> to provide layer of continuous insulation</p> <p>Upper vent openings will be covered with <i>SPF</i>, including ridge, roof, and gable that are covered with a substrate</p> <p>In colder climates (<i>IECC</i> Zones 5-8), <i>SPF</i> will be installed to a thickness of least Class II <i>vapor retarder</i> or have at least Class II <i>vapor retarder</i> coating or covering in direct contact with the underside of the <i>SPF</i></p>	<p>Ensure complete and consistent coverage throughout roof plane</p> <p>Eliminate cracks, gaps, and voids</p> <p>Improve structural integrity of roof deck (closed cell <i>SPF</i> only)</p> <p>Ensure alignment of insulation and <i>air barrier</i></p>
4.1003.5b Onsite documentation	<p>A dated receipt signed by the installer will be provided that includes:</p> <ul style="list-style-type: none"> • Coverage area • Thickness • R-value 	<p>Document job completion to contract specifications</p> <p>Confirm amount of insulation installed</p> <p>Comply with 16 CFR 460.17</p>
PA WAP Guidance:	See PA SWS Field Manual, Chapter 4: Insulation, section on Insulation Certificate for PA WAP guidance	
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

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

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

Title	Specification(s)	Objective(s)
4.1003.6a Installation	<p>Insulation will be installed at the ceiling level to prescribed R-value in accordance with manufacturer specifications</p> <p><i>SPF</i> will be applied to desired thickness, using pass thickness maximum as indicated by manufacturer, onto roof sheathing between rafters or trusses</p> <p>In colder climates (<i>IECC</i> Zones 5-8), <i>SPF</i> will be installed to a thickness of least Class II <i>vapor retarder</i> or have at least Class II <i>vapor retarder</i> coating or covering in direct contact with the underside of the <i>SPF</i></p>	<p>Ensure complete and consistent coverage throughout ceiling plane</p> <p>Eliminate cracks, gaps, and voids</p> <p>Ensure alignment of insulation and <i>air barrier</i></p>
4.1003.6b Onsite documentation	<p>A dated receipt signed by the installer will be provided that includes:</p> <ul style="list-style-type: none">• Coverage area• Thickness• R-value	<p>Document job completion to contract specifications</p> <p>Confirm amount of insulation installed</p> <p>Comply with 16 CFR 460.17</p>
PA WAP Guidance:	See PA SWS Field Manual, Chapter 4: Insulation, section on Insulation Certificate for PA WAP guidance	
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

Desired Outcome: Meet building code requirements for fire protection of spray polyurethane foam

For supporting material, see [Referenced Standards](#) and [General Information on Spray Polyurethane Foam \(SPF\)](#).

Title	Specification(s)	Objective(s)
4.1003.7a Identify fire safety requirements	Meet or exceed local fire safety requirements for installation of <i>SPF</i> foam Consult local codes to ensure installation complies with fire safety requirements If code requirements are unclear, consult local code officials for clarification	Ensure <i>SPF</i> 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 <i>ignition barrier</i> covering or coating Check manufacturer specifications and/or local codes for appropriate <i>ignition barrier</i> coatings/materials	Protect <i>SPF</i> 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 <i>SPF</i> 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

Subtopic 4.1004 Knee Walls

4.1004.1 Preparation for Dense Packing

Topic: Attics

Subtopic: Knee Walls

Desired Outcome: Airtight cavity and insulated [knee wall](#)

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

Title	Specification(s)	Objective(s)
4.1004.1a Backing	<p>All knee walls will have top and bottom plate or blockers installed using rigid materials</p> <p>When knee wall floor and walls are being insulated, the floor joist running under the knee wall will be air sealed</p> <p>If fabric is used before dense packing, it will be secured, according to manufacturers specifications or with furring strips every wall stud</p> <p>If rigid material is used, material will be installed to cover 100% of the surface of the accessible knee wall area</p> <p>If foam sheathing is used, sheathing will be listed for uncovered use in an attic or covered with a fire barrier</p>	<p>Eliminate bending, sagging, or movement that may result in air leakage</p> <p>Prevent air leakage through the top or bottom of the knee wall</p> <p>Ensure material will not tear under stress from wind loads or insulation</p>



Before

Knee walls often need sealing and insulation

Tools:

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



After

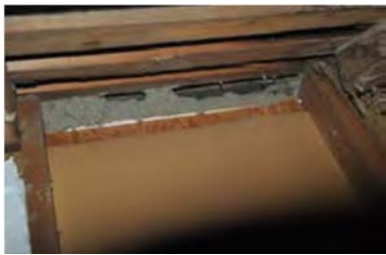
Knee wall is prepped for dense pack insulation

Materials:

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

Title	Specification(s)	Objective(s)
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4.1004.1a Backing



Knee walls missing top plates need one created from rigid material



Top plate holds dense pack insulation in cavity



New top plate should be sealed to surrounding joists and studs



Bottom plates also need to be installed. Measure for size



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



Seal to surrounding joist



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



Drywall is also a good barrier for dense packing knee walls

Title	Specification(s)	Objective(s)
4.1004.1b Installation	<p>All existing batted insulation will be adjusted to ensure it is in full contact with the interior cladding and the top and bottom plates</p> <p>Insulation that is blown behind fabric or <i>air barrier</i> material will be blown dense to a minimum specification of 3.5 pounds per cubic foot for cellulose</p> <p>Follow manufacturer's requirements for fiberglass <i>dense pack</i> applications</p>	<p>Eliminate misalignment of existing insulation</p> <p>Prevent insulation from settling or moving</p>



Before

Existing batt insulation should be adjusted to fit properly



After

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



Attach furring strips to create pockets for dense-pack insulation



Insulation should meet manufacturer specifications for density

4.1004.2 Preparation for Batt Insulation

Topic: Attics

Subtopic: Knee Walls

Desired Outcome: Airtight cavity and properly insulated [knee wall](#)

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



Before

Top plate is missing from knee wall



After

New top plate is sealed to adjacent framing

Tools:

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

Materials:

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

Title	Specification(s)	Objective(s)
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4.1004.2a Knee wall prep for batts



Top plate has been cut and fit to size



Top plate has been sealed to adjacent framing



Bottom plate is also missing. Space is measured so XPS can be cut



Bottom plate is cut to size



Bottom plate is placed in line with interior air barrier



Bottom plate is also sealed to surrounding joist and framing

Title	Specification(s)	Objective(s)
4.1004.2b Installation	<p>Insulation will be installed using one of the following methods:</p> <ul style="list-style-type: none"> • 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



Before

Knee wall with batts improperly installed and missing from stud bays



After

Properly fit insulation filling full volume of stud bay

Tools:

1. Utility knife
2. Tape measure

Materials:

1. Fiberglass batts



Where existing insulation is improperly installed, fix it



Kraft-face should go toward you and batt should fill bay



Batts should fill entire volume of knee wall stud bays

Title	Specification(s)	Objective(s)
4.1004.2c Backing knee wall	<p>If <i>rigid material</i> is used, material will be installed to cover 100% of the surface of the <i>knee wall</i></p> <p>If foam sheathing is used, sheathing will be listed for uncovered use in attic, or covered with a fire barrier</p>	Prevent insulation from settling or moving



Before

Knee walls with batt insulation require covering

Tools:

1. Utility knife
2. Tape measure
3. Drill



After

Foam sheathing? Needs to be covered with a fire barrier

Materials:

1. Drywall
2. House wrap



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



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

4.1004.3 Strapping for Existing Insulation

Topic: Attics

Subtopic: Knee Walls

Desired Outcome: Consistent, uniform [thermal boundary](#) between the conditioned space and unconditioned space to prescribed R-value

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

Desired Outcome: Consistent uniform [thermal boundary](#) between the conditioned space and unconditioned space to prescribed R-value

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	A dated receipt signed by the installer will be provided that includes: <ul style="list-style-type: none">• Coverage area• Thickness• R-value	Document job completion to contract specifications Confirm amount of insulation installed Comply with 16 CFR 460.17
PA WAP Guidance:	See PA SWS Field Manual, Chapter 4: Insulation, section on Insulation Certificate for PA WAP guidance	

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

Topic: Attics

Subtopic: Knee Walls

Desired Outcome: Airtight and insulated knee and gable end walls

For supporting material, see [General Information on Spray Polyurethane Foam \(SPF\)](#) and [Referenced Standards](#).

Title	Specification(s)	Objective(s)
4.1004.5a Installation of backing	<p>Knee walls will have a top and bottom plate or blockers installed using a <i>rigid material</i></p> <p>A suitable backstop material attached to the back of the <i>knee wall</i> will be used to support the application of <i>SPF</i></p> <p>If foam sheathing is used as a backstop, sheathing will be listed for uncovered use in an attic or covered with an <i>ignition barrier</i>, thermal barrier, or approved alternate assembly</p>	<p>Provide a backstop or substrate for application of <i>SPF</i></p>
4.1004.5b Installation	<p>Insulation will be installed to prescribed R-value</p> <p>Using <i>SPF</i> application, <i>SPF</i> 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</p> <p>In colder climates (<i>IECC</i> Zones 5-8), the <i>SPF</i> will be installed to a thickness of at least Class II <i>vapor retarder</i> or have at least Class II <i>vapor retarder</i> coating or covering in direct contact with the interior of the <i>SPF</i></p>	<p>Eliminate cracks, gaps, and voids</p> <p>Minimize framing cavity air flows</p> <p>Minimize moisture migration and unwanted condensation in insulation (vapor retarders)</p> <p>Ensure alignment of insulation and <i>air barrier</i></p>
4.1004.5c Onsite documentation	<p>A dated receipt signed by the installer will be provided that includes:</p> <ul style="list-style-type: none"> • Coverage area • Thickness • R-value 	<p>Document job completion to contract specifications</p> <p>Confirm amount of insulation installed</p> <p>Comply with 16 CFR 460.17</p>
PA WAP Guidance:	See PA SWS Field Manual, Chapter 4: Insulation, section on Insulation Certificate for PA WAP guidance	

Subtopic 4.1005 Attic Floors

4.1005.1 Accessible Floors—Batt Installation

Topic: Attics

Subtopic: Attic Floors

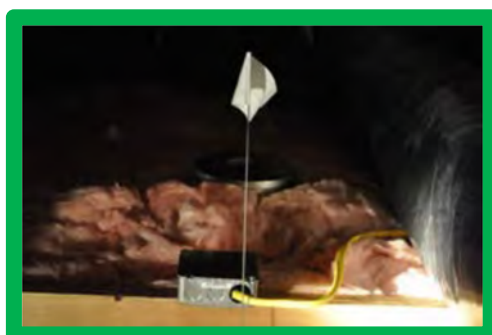
Desired Outcome: Consistent, [thermal boundary](#) between conditioned and unconditioned space controls the heat flow

Title	Specification(s)	Objective(s)
4.1005.1a Preparation	<p>Subfloor or drywall will be removed to access cavities as necessary, including inaccessible knee-wall attic floor spaces</p> <p>All electrical junctions will be flagged to be seen above the level of the insulation</p> <p>Open electrical junction boxes will have covers installed</p>	<p>Access the workspace</p> <p>Provide location of electrical junctions for future servicing</p> <p>Prevent an electrical hazard</p>



Before

Remove flooring in attic spaces to access floor cavities and insulate



After

If electrical junctions are found, they should be enclosed and flagged to make future maintenance and repairs easier

Tools:

1. Hammer
2. Pry bar

Materials:

1. Flags



Pry up flooring to access floor cavities



Check cavity for electrical junctions and penetrations



Air seal any penetrations

Title	Specification(s)	Objective(s)
4.1005.1b Installation	<p>Batt insulation will be installed in accordance with manufacturer specifications without gaps, voids, compressions, misalignments, or wind intrusions</p> <p>Insulation will be installed to the prescribed R-value</p>	Insulate to prescribed R-value



Before

Accessible attic floors should be air sealed and insulated



After

Insulate floor cavities to prescribe R-value from the work order

Tools:

1. Hammer
2. Utility knife
3. Tape measure

Materials:

1. Fiberglass batts



Insert fiberglass batts into floor cavities, kraft-face down



Fill entire volume of floor cavity



Once insulated, flooring should be reinstalled

Title	Specification(s)	Objective(s)
4.1005.1c Occupant education	<p>A dated receipt signed by the installer will be provided that includes:</p> <ul style="list-style-type: none"> • Coverage area • Thickness • R-value 	<p>Document job completion to contract specifications</p> <p>Confirm amount of insulation installed</p> <p>Comply with 16 CFR 460.17</p>
PA WAP Guidance:	See PA SWS Field Manual, Chapter 4: Insulation, section on Insulation Certificate for PA WAP guidance	



Best Practice

Provide occupant with documentation of and about insulation installed



Communicate professionally with occupant to provide information and support



Documentation should include insulation material and r-value

4.1005.2 Accessible Floors—Loose Fill Installation

Topic: Attics

Subtopic: Attic Floors

Desired Outcome: Consistent, [thermal boundary](#) between conditioned and unconditioned space controls the heat flow

For supporting material, see [Calculation of the Infiltration Credit](#) and [Referenced Standards](#).

Title	Specification(s)	Objective(s)
4.1005.2a Preparation	<p>Subfloor or drywall will be removed to access cavities as necessary, including inaccessible knee-wall attic floor spaces</p> <p>Insulation will be adequately marked for depth a minimum of every 300 square feet of attic area, with measurement beginning at the air barrier</p> <p>All electrical boxes will be flagged to be seen above the level of the insulation</p> <p>Open electrical junctions will have covers installed</p> <p>Insulation dams and enclosures will be installed as required</p>	<p>Access the workspace</p> <p>Verify uniformity of insulation material</p> <p>Provide location of electrical boxes for future servicing</p> <p>Prevent an electrical hazard</p>



Before

Accessible attic floors should be air sealed and insulated

Tools:

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



After

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

Materials:

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

Title	Specification(s)	Objective(s)
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4.1005.2a Preparation



Check cavity for electrical junctions and penetrations



Flag and install covers on electrical junctions



Seal any penetrations



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



Install depth markers and insulation dams above height of insulation

Title	Specification(s)	Objective(s)
4.1005.2b Air barrier	Existence of <i>air barrier</i> material in line with the knee walls will be installed or verified when dense packing <i>Air barrier</i> material will not bend, sag, or move once dense packed	Hold <i>dense pack</i> in place



Before

When missing, blocking must be installed under knee walls

Tools:

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



After

New blocking completes air barrier and holds insulation in place

Materials:

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



Measure floor cavity for new blocking



Cut rigid material, such as XPS, to size to snugly fit into cavity



Align block with air barrier of conditioned space



Air seal around new blocking with spray foam

Title	Specification(s)	Objective(s)
4.1005.2c Installation	All insulation will be installed to the depth indicated on the manufacturer coverage chart for desired R-value	<p>Reduce heating and air conditioning costs</p> <p>Improve comfort</p> <p>Minimize noise</p>



Before

Accessible attic floor should be air sealed and insulated



After

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

Tools:

1. Insulation machine

Materials:

1. Loose fill insulation



Use depth markers to ensure insulation has reached prescribed R-value



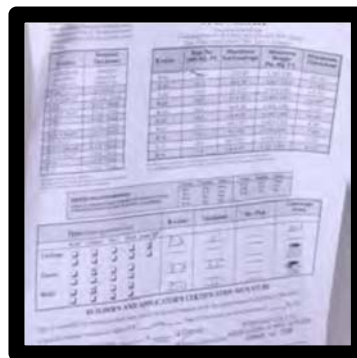
Where flooring cannot be removed, verify insulation is meeting R-value goal

Title	Specification(s)	Objective(s)
4.1005.2d Onsite documentation	<p>A dated receipt signed by the installer will be provided that includes:</p> <ul style="list-style-type: none"> • Insulation type • Coverage area • R-value • Installed thickness and settled thickness • Number of bags installed in accordance with manufacturer specifications 	<p>Document job completion to contract specifications</p> <p>Confirm amount of insulation installed</p> <p>Ensure ability to match bags required for total area completed</p> <p>Comply with 16 CFR 460.17</p>
PA WAP Guidance:	See PA SWS Field Manual, Chapter 4: Insulation, section on Insulation Certificate for PA WAP guidance	



Best Practice

Information on insulation installed should be posted nearby



Best Practice

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

Paraphrased from 16 CFR 460.17: If you are an installer, you must give your customers a contract or receipt for the insulation you install.

The certificate must be signed and dated by the Crew Chief. For all insulation, the certificate must show the insulation's coverage area, initial installed thickness, and R-value of the installed insulation. To figure out the R-value of the insulation, use the data that the manufacturer gives you.

For loose-fill insulation only, in addition to the requirements above, the certificate must also show the insulation's minimum settled thickness, and the number of bags used.

4.1005.3 Accessible Floors—Batt Insulation Over Existing Insulation

Topic: Attics

Subtopic: Attic Floors

Desired Outcome: Insulation controls heat transfer through ceiling

Title	Specification(s)	Objective(s)
4.1005.3a Preparation	Existing insulation will be in contact with the <i>air barrier</i> prior to installing additional insulation on top	Ensure proper performance of insulation
4.1005.3b Installation	<p>If the top of the existing insulation is below the top of the framing, new batts will be installed parallel with framing members</p> <p>If the top of the existing insulation is above the top of the framing, new batts will be installed perpendicular to framing members</p>	<p>Ensure uniform depth of insulation in continuous contact with existing insulation</p> <p>Eliminate voids and gaps</p>
4.1005.3c Insulation	<p>A dated receipt signed by the installer will be provided that includes:</p> <ul style="list-style-type: none"> • Coverage area • Thickness • R-value 	<p>Document job completion to contract specifications</p> <p>Confirm amount of insulation installed</p> <p>Ensure ability to match bags required for total area completed</p> <p>Comply with 16 CFR 460.17</p>
PA WAP Guidance:	See PA SWS Field Manual, Chapter 4: Insulation, section on Insulation Certificate for PA WAP guidance	
4.1005.3d Safety	Insulation will not be allowed on top of non- <i>IC</i> rated <i>can light</i> boxes or between a heat generating appliance and a dam, unless material is rated for contact with heat generating sources	Prevent a fire hazard

Title	Specification(s)	Objective(s)
4.1005.3e Occupant education	Documentation of material and R-value will be provided to occupant	Provide occupant with documentation of installation



Best Practice

Provide occupant with documentation of and about insulation installed



Communicate professionally with occupant to provide information and support



Documentation should include insulation material and r-value

4.1005.4 Accessible Floors—Loose Fill Over Existing Insulation

Topic: Attics

Subtopic: Attic Floors

Desired Outcome: Insulation controls heat transfer through ceiling

For supporting material, see [Calculation of the Infiltration Credit](#) and [Referenced Standards](#).

Title	Specification(s)	Objective(s)
4.1005.4a Preparation	<p>Existing insulation will be in contact with the air barrier prior to installing additional insulation on top</p> <p>Insulation will be adequately marked for depth a minimum of every 300 square feet of attic area, with measurement beginning at the air barrier</p> <p>All electrical junction boxes will be flagged to be seen above the level of the insulation</p> <p>Open electrical junction boxes will have covers installed</p> <p>Insulation dams and enclosures will be installed as required</p>	<p>Ensure proper performance of insulation Verify uniformity of insulation material Provide location of electrical junctions for future servicing</p> <p>Prevent an electrical hazard</p>
4.1005.4b Installation	<p>The correct depth and number of bags will be blown in accordance with manufacturer specifications</p> <p>Insulation will be installed to prescribed R-value</p>	<p>Insulate to prescribed R-value</p>
4.1005.4c Safety	<p>Insulation will not be allowed on top of non- IC can light boxes or between a heat-generating appliance and a dam, unless material is rated for contact with heat generating sources</p>	<p>Prevent a fire hazard</p>
4.1005.4d Onsite documentation	<p>A dated receipt signed by the installer will be provided that includes:</p> <ul style="list-style-type: none"> • Insulation type • Coverage area • R-value • Installed thickness and minimum settled thickness • Number of bags installed in accordance with manufacturer specifications 	<p>Document job completion to contract specifications</p> <p>Confirm amount of insulation installed</p> <p>Ensure ability to match bags required for total area completed</p> <p>Comply with 16 CFR 460.17</p>
PA WAP Guidance:	See PA SWS Field Manual, Chapter 4: Insulation, section on Insulation Certificate for PA WAP guidance	

Title	Specification(s)	Objective(s)
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4.1005.4d Onsite documentation



Best Practice

Written documentation of insulation type and efficiency will be provided



Best Practice

Information should include depth of loose fill installed and once settled

Paraphrased from 16 CFR 460.17: If you are an installer, you must give your customers a contract or receipt for the insulation you install.

The certificate must be signed and dated by the Crew Chief. For all insulation, the certificate must show the insulation's coverage area, initial installed thickness, and R-value of the installed insulation. To figure out the R-value of the insulation, use the data that the manufacturer gives you.

For loose-fill insulation only, in addition to the requirements above, the certificate must also show the insulation's minimum settled thickness, and the number of bags used.

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

Topic: Attics

Subtopic: Attic Floors

Desired Outcome: A consistent [thermal boundary](#) between conditioned and unconditioned space controls the heat flow

For supporting material, see [Calculation of the Infiltration Credit](#) and [Referenced Standards](#).

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



Before

This finished garage below a bonus room is an unconditioned space



After

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

Tools:

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

Materials:

1. XPS or other rigid material

Title	Specification(s)	Objective(s)
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4.1005.5a Air barrier



Snap chalk lines to keep access cuts clean and easy to repair



Cut through garage ceiling to access joist cavities below bonus room



The rigid block should be placed in line with the stem wall above



Measure joist cavity depth



Measure joist cavity width



Cut XPS, or other rigid material, to measured size of joist cavity



Rigid block should fit snugly into joist cavity to prevent insulation leaks



Rigid block will hold the insulation in place under the bonus room above

Title	Specification(s)	Objective(s)
4.1005.5b Fill floors	<p>Each cavity will be 100% filled to consistent density:</p> <ul style="list-style-type: none"> Cellulose material will be installed to a minimum density of 3.5 pounds per cubic foot Loose fiberglass material will be installed and will be specifically approved for air flow resistance to a minimum density per the manufacturer's recommendations <p>The number of bags installed will be confirmed and will match the number required on the coverage chart</p> <p>Insulation will be verified to prevent visible air movement using chemical smoke at 50 pascals of pressure difference</p>	<p>Eliminate voids and settling</p> <p>Minimize framing cavity air flows</p>



Before

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



After

Chemical smoke at 50pa indicates insulation is at appropriate density

Tools:

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

Materials:

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



Blow insulation into cavities to density appropriate for chosen material



Close cavities with access panel cut out at the beginning



Tape and spackle access panel

Title	Specification(s)	Objective(s)
4.1005.5c Safety	Insulation will not be allowed on top of non- <i>IC</i> rated <i>can light</i> boxes or between a heat-generating appliance and a dam, unless material is rated for contact with heat generating sources	Prevent a fire hazard



Before

Insulation is not held back by dams around flues, chimneys, and light fixtures



After

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



No insulation on top of non-insulation contact (non-IC) rated fixtures

4.1005.5d Onsite documentation	<p>A dated receipt signed by the installer will be provided that includes:</p> <ul style="list-style-type: none"> • Coverage area • Thickness • R-value 	<p>Document job completion to contract specifications</p> <p>Confirm amount of insulation installed</p> <p>Comply with 16 CFR 460.17</p>
PA WAP Guidance:	See PA SWS Field Manual, Chapter 4: Insulation, section on Insulation Certificate for PA WAP guidance	

Title	Specification(s)	Objective(s)
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4.1005.5d Onsite documentation



After

Documentation of insulation installed should be provided in writing

Paraphrased from 16 CFR 460.17: If you are an installer, you must give your customers a contract or receipt for the insulation you install.

The certificate must be signed and dated by the Crew Chief. For all insulation, the certificate must show the insulation's coverage area, initial installed thickness, and R-value of the installed insulation. To figure out the R-value of the insulation, use the data that the manufacturer gives you.

For loose-fill insulation only, in addition to the requirements above, the certificate must also show the insulation's minimum settled thickness, and the number of bags used.

4.1005.6 Enclosed Attic Storage Platform Floor—Dense Pack Installation

Topic: Attics

Subtopic: Attic Floors

Desired Outcome: Insulation reduces heat flow through floor and framing cavities inaccessible to other treatments

For supporting material, see [Calculation of the Infiltration Credit](#) and [Referenced Standards](#).

Title	Specification(s)	Objective(s)
4.1005.6a Fill floors	<p>Each cavity will be 100% filled to consistent density:</p> <ul style="list-style-type: none"> Cellulose material will be installed to a minimum density of 3.5 pounds per cubic foot Loose fiberglass material will be installed and will be specifically approved for air flow resistance to a minimum density per the manufacturer's recommendations <p>The number of bags installed will be confirmed and will match the number required on the coverage chart</p> <p>Insulation will be verified to prevent visible air movement using chemical smoke at 50 pascals of pressure difference</p>	<p>Eliminate voids and settling</p> <p>Minimize framing cavity air flows</p>
4.1005.6b Safety	<p>Insulation will not be allowed on top of non- <i>IC</i> rated <i>can light</i> boxes or between a heat generating appliance and a dam, unless material is rated for contact with heat generating sources</p>	<p>Prevent a fire hazard</p>
4.1005.6c Onsite documentation	<p>A dated receipt signed by the installer will be provided that includes:</p> <ul style="list-style-type: none"> Coverage area Thickness R-value 	<p>Document job completion to contract specifications</p> <p>Confirm amount of insulation installed</p> <p>Comply with 16 CFR 460.17</p>
PA WAP Guidance:	See PA SWS Field Manual, Chapter 4: Insulation, section on Insulation Certificate for PA WAP guidance	

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

Topic: Attics

Subtopic: Attic Floors

Desired Outcome: Consistent, [thermal boundary](#) and [air barrier](#) between conditioned and unconditioned space controls the heat flow and air leakage

For supporting material, see [Calculation of the Infiltration Credit](#) and [Referenced Standards](#).

Title	Specification(s)	Objective(s)
4.1005.7a Preparation	<p>Subfloor or drywall will be removed to access cavities as necessary (e.g., beneath attic knee walls)</p> <p>All electrical junctions will be flagged to be seen above the level of the insulation</p> <p>Open electrical junction boxes will have covers installed</p>	<p>Access the workspace</p> <p>Provide location of electrical junctions for future servicing</p> <p>Prevent an electrical hazard</p>
4.1005.7b Installation	<p>Insulation will be installed to prescribed R-value</p> <p>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</p>	<p>Insulate to prescribed R-value</p>
4.1005.7c Safety	<p>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</p>	<p>Prevent a fire hazard</p>
4.1005.7d Onsite documentation	<p>A dated receipt signed by the installer will be provided that includes:</p> <ul style="list-style-type: none"> • Coverage area • Thickness • R-value 	<p>Document job completion to contract specifications</p> <p>Confirm amount of insulation installed</p> <p>Comply with 16 CFR 460.17</p>
PA WAP Guidance:	See PA SWS Field Manual, Chapter 4: Insulation, section on Insulation Certificate for PA WAP guidance	
4.1005.7e Occupant education	<p>Documentation of material and R-value will be provided to occupant</p>	<p>Provide occupant with documentation of installation</p>

Subtopic 4.1006 Attic Openings

4.1006.1 Pull-Down Stairs

Topic: Attics

Subtopic: Attic Openings

Desired Outcome: Pull-down attic stair properly sealed and insulated

For supporting material, see [Calculation of the Infiltration Credit](#) and [Referenced Standards](#).

Title	Specification(s)	Objective(s)
4.1006.1a Installation	<p>Hatches will be insulated to the maximum R-value structurally allowable up to the R-value of the adjoining insulated assembly</p> <p>Pull-down stair rough opening will be surrounded with a durable dam that is higher than the level of the attic floor insulation</p> <p>Counter-weights should be considered to ease accessibility for excessively heavy hatches</p>	<p>Achieve uniform R-value</p> <p>Prevent loose insulation from entering the living area</p>



Before

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

Tools:

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

Materials:

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



After

Insulated pull-down stairs cover installed to prevent air leakage



Stairs and hatch should both be insulated to match r-value of attic

Title	Specification(s)	Objective(s)
4.1006.1b Sealing	<p>Entire pull-down stair assembly will be covered with an airtight and removable/openable enclosure inside the attic space</p> <p>Pull-down stair frame will be caulked, gasketed, weatherstripped, or otherwise sealed with an <i>air barrier</i> material, suitable film, or solid material that allows attic door operation</p>	Prevent air leakage



Before

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



After

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

Tools:

1. Caulk gun

Materials:

1. Weatherstripping
2. Foam board
3. Caulk



Seal around frame of pull-down stairs with appropriate sealant



Weatherstrip around stair panel to encourage a tight seal



Remember to seal finish details and trim



Remember to seal finish details and trim

Title	Specification(s)	Objective(s)
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	<p>A dated receipt signed by the installer will be provided that includes:</p> <ul style="list-style-type: none"> • Coverage area • Thickness • R-value 	<p>Document job completion to contract specifications</p> <p>Confirm amount of insulation installed</p> <p>Comply with 16 CFR 460.17</p>
PA WAP Guidance:	See PA SWS Field Manual, Chapter 4: Insulation, section on Insulation Certificate for PA WAP guidance	

4.1006.2 Access Doors and Hatches

Topic: Attics

Subtopic: Attic Openings

Desired Outcome: Attic access door properly sealed and insulated

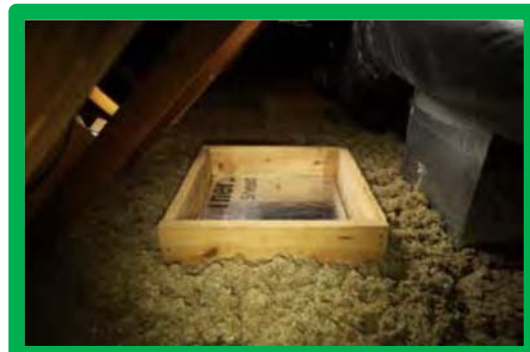
For supporting material, see [Calculation of the Infiltration Credit](#) and [Referenced Standards](#).

Title	Specification(s)	Objective(s)
4.1006.2a Installation	<p>Hatches will be insulated to the maximum R-value structurally allowable up to the R-value of the adjoining insulated assembly</p> <p>Attic hatches rough opening will be surrounded with a durable protective baffle that is higher than the level of the surrounding attic floor insulation</p>	<p>Achieve uniform R-value on the attic door or hatch</p> <p>Achieve uniform R-value on the attic floor</p> <p>Prevent loose attic floor insulation from entering the living area</p>



Before

Uninsulated attic hatches and access panels weaken the thermal envelope



After

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

Materials:

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

Title	Specification(s)	Objective(s)
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4.1006.2a Installation



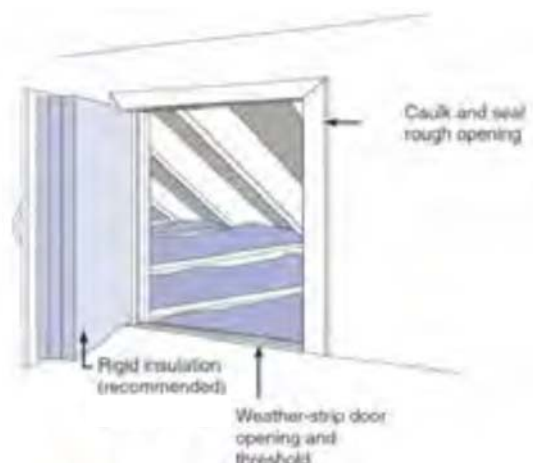
1. Create hatch cover that matches r-value of surrounding insulation



2. Building dam to hold back attic insulation and hold cover in place tightly



3. Weatherstrip underside of hatch cover to create tight seal



4. Alternate installation for vertical access panel to attic

Title	Specification(s)	Objective(s)
4.1006.2b Sealing	<p>Access hatch frames will be sealed using caulk, gasket, weatherstrip, or otherwise sealed with an <i>air barrier</i> material, suitable film, or solid material</p> <p>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</p> <p>The measure must include a protective baffle or insulation barrier</p>	Prevent air leakage



Before

Unsealed attic hatches and panel doors allow air leakage to and from attic



After

Once sealed, air leakage at attic hatch or door should be minimized

Materials:

1. Weatherstripping
2. 3/4" Lumber
3. Caulk



Remember to seal around finish details and framing on interior



Build insulation dam from 3/4 inch lumber and seal around base



Weatherstrip around bottom edge of hatch cover to create air tight seal

Title	Specification(s)	Objective(s)
4.1006.2c Attachment	Insulation will be permanently attached and in complete contact with the <i>air barrier</i>	Insulate to prescribed R-value



Before

Unsealed and uninsulated attic hatches and access doors allow leakage



After

Rigid insulation on back of new hatch cover attached firmly and squarely to allow for airtight

Materials:

1. Weatherstripping
2. 3/4" Lumber
3. Caulk



1. Apply foam tape to "warm side" face of attic hatch



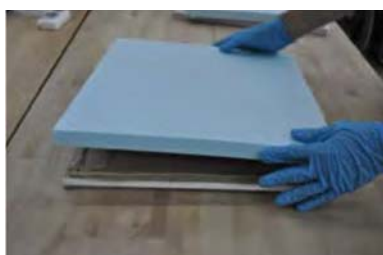
2. Ensure an air tight seal by making sure foam tape has no gaps



3. Apply strong adhesive to "cold-side" of hatch



4. Adhesive should ring perimeter as well as criss-crossing hatch to ensure complete attachment of insulation



5. Affix XPS insulation to "cold-side" of hatch with adhesive, ensuring XPS is tight and square to hatch



6. Repeat adhesive to XPS layers to reach maximum R-value without making hatch excessively heavy or awkward



7. All XPS layers should be attached firmly to one another and square to hatch

Title	Specification(s)	Objective(s)
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	<p>A dated receipt signed by the installer will be provided that includes:</p> <ul style="list-style-type: none"> • Coverage area • Thickness • R-value 	<p>Document job completion to contract specifications</p> <p>Confirm amount of insulation installed</p> <p>Comply with 16 CFR 460.17</p>
PA WAP Guidance:	See PA SWS Field Manual, Chapter 4: Insulation, section on Insulation Certificate for PA WAP guidance	

4.1006.3 Whole-House Fan

Topic: Attics

Subtopic: Attic Openings

Desired Outcome: Consistent, uniform [thermal boundary](#) between the conditioned space and unconditioned space to prescribed R-value of an adjoining insulated assembly

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	<p>Fan insulation box frame will be continuously weatherstripped to ensure a tight fit</p> <p>Fan insulation box will be constructed at a depth to protect the fan housing and motor from insulation</p>	Prevent air leakage
4.1006.3c Attachment	<p>Non-compressible insulation will be permanently attached in contact with fan insulation box</p> <p>Appropriate adhesive or mechanical fastener will be used</p>	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

Subtopic 4.1088 Special Considerations

4.1088.1 Attic Ventilation

Topic: Attics

Subtopic: Special Considerations

Desired Outcome: Properly restored vents minimize moisture and ice dams

For supporting material, see [Calculation of the Infiltration Credit](#) and [Referenced Standards](#).

Title	Specification(s)	Objective(s)
4.1088.1a Air barrier and thermal boundary	<p>Attic ventilation will be recommended or installed if local code requires attic ventilation during weatherization or retrofits</p> <p>The presence of an effective <i>air barrier</i> and <i>thermal boundary</i> between the attic and the living space must be verified and appropriate attic sealing and proper insulation is specified as part of the scope of work</p>	Ensure presence of continuous <i>air barrier</i> and <i>thermal boundary</i>
4.1088.1b Vent type	<p>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)</p> <p>Attic-powered ventilators will not be used</p>	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	<p>Encourage proper air flow</p> <p>Minimize entry of wind driven rain or snow</p>
4.1088.1d Ventilation baffling	<p>Baffling for attic soffit vents will be installed to:</p> <ul style="list-style-type: none"> • 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	<p>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)</p> <p>Existing vents that are not screened will be covered with non-corroding wire mesh with openings of 1/16" to 1/4"</p> <p>Ensure net free area requirements are met</p> <p>Additional vents or larger vents can be added if screen size is smaller than designated</p>	Prevent pest entry

4.1088.2 Radiant Barrier

Topic: Attics

Subtopic: Special Considerations

Desired Outcome: Radiant heat flow reduced

Title	Specification(s)	Objective(s)
4.1088.2a Stapling	An air space no less than $\frac{3}{4}$ " 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 $\frac{3}{4}$ " 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
4.1088.2e Onsite documentation	A dated receipt signed by the installer will be provided that includes: <ul style="list-style-type: none">• Number and thickness of air spaces• R-value• Direction of heat flow	Document job completion to contract specifications Comply with 16 CFR 460.17

4.1088.3 Skylights

Topic: Attics

Subtopic: Special Considerations

Desired Outcome: Consistent, uniform [thermal boundary](#) between the conditioned space and unconditioned space to prescribed R-value

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



Before

Unsealed and uninsulated attic hatches and access doors allow leakage

Tools:

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



After

Rigid insulation on back of new hatch cover attached firmly and squarely to allow for airtight

Materials:

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

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

Title	Specification(s)	Objective(s)
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4.1088.3b Installation



1. Skylight well is uninsulated



2. Carefully seal all seams and joints



3. Install insulation in complete contact with all sides of the cavity



4. Install an attic-side air barrier



5. The air barrier may be constructed from rigid insulation board. Seal the attic side air barrier

Title	Specification(s)	Objective(s)
4.1088.3c Occupant education	<p>A dated receipt signed by the installer will be provided that includes:</p> <ul style="list-style-type: none"> • Insulation type • Coverage area • R-value • Installed thickness and settled thickness (settled thickness required for loose-fill only) • Number of bags installed in accordance with manufacturer specifications (for loose-fill only) 	<p>Document job completion to contract specifications</p> <p>Confirm amount of insulation installed</p> <p>Comply with 16 CFR 460.17</p>
PA WAP Guidance:	See PA SWS Field Manual, Chapter 4: Insulation, section on Insulation Certificate for PA WAP guidance	



Best Practice

Provide occupant with documentation of and about insulation installed



Communicate professionally with occupant to provide information and support



Documentation should include insulation material and r-value

4.1088.4 Parapet Walls—Dense Pack

Topic: Attics

Subtopic: Special Considerations

Desired Outcome: Properly installed insulation reduces heat flow through parapet wall

Title	Specification(s)	Objective(s)
4.1088.4a Access	<p>Proper access in wall exterior or interior containment area will be ensured</p> <p>Lead safety procedures in houses built before 1978 will be followed in accordance with EPA Healthy Indoor Environment Protocols for Home Energy Upgrades</p>	Protect worker and occupant health
PA WAP Guidance:	<p>Refer to PA WAP Health and Safety Plan.</p> <p>Remember to document lead-safe work practices in the Client File (photos).</p>	
4.1088.4b Installation	<i>Dense pack</i> insulation will be installed in accordance with manufacturer specifications at void area	Seal wall
4.1088.4c Onsite documentation	<p>A dated receipt signed by the installer will be provided that includes:</p> <ul style="list-style-type: none"> • Coverage area • Thickness • R-value 	<p>Document job completion to contract specifications</p> <p>Confirm amount of insulation installed</p> <p>Comply with 16 CFR 460.17</p>
PA WAP Guidance:	See PA SWS Field Manual, Chapter 4: Insulation, section on Insulation Certificate for PA WAP guidance	

4.1088.5 Parapet Walls—Spray Polyurethane Foam (SPF)

Topic: Attics

Subtopic: Special Considerations

Desired Outcome: Properly installed insulation reduces heat flow through parapet wall

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

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
PA WAP Guidance:	Refer to PA WAP Health and Safety Plan. Remember to document lead-safe work practices in the Client File (photos).	
4.1088.5b Installation	SPF insulation will be installed in accordance with manufacturer specifications at void area	Seal and insulate wall
4.1088.5c Onsite documentation	A dated receipt signed by the installer will be provided that includes: <ul style="list-style-type: none">• Coverage area• Thickness• R-value	Document job completion to contract specifications Confirm amount of insulation installed Comply with 16 CFR 460.17
PA WAP Guidance:	See PA SWS Field Manual, Chapter 4: Insulation, section on Insulation Certificate for PA WAP guidance	

Topic 4.11 Walls

Subtopic 4.1101 Preparation

4.1101.1 Exterior Wall Dense Packing

Topic: Walls

Subtopic: Preparation

Desired Outcome: Walls properly prepared to receive [dense pack](#) insulation

For supporting material, see [Calculation of the Infiltration Credit](#) and [Referenced Standards](#).

Title	Specification(s)	Objective(s)
4.1101.1a Preparation	<p>Lead and asbestos safety procedures will be followed</p> <p>Cavities will be free of hazards, intact, and able to support dense pack pressures</p> <p>Drilling hazards (e.g., wiring, venting, fuel piping) will be located</p> <p>Blocking will be installed around:</p> <ul style="list-style-type: none">• All openings to inside crawl space and basement for fibrous material• High temperature fire-rated materials• Wiring and electrical hazards• Heat sources <p>Access to exterior wall cavities will be gained, sheathing will be drilled as needed and probed to locate each cavity, wall studs, and blockers</p> <p>Interior will be masked and dust controlled during drilling when accessing from interior</p> <p>Electricity supply will be confirmed and will support blowing machine power demand</p> <p>Blowing machine pressure test will be performed with air on full, feed off, agitator running, and gate closed</p> <p>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</p>	<p>Prevent damage to house</p> <p>Provide a clean work space</p> <p>Provide thorough access to allow 100% coverage</p> <p>Ensure proper equipment and process results in consistent density</p> <p>Prevent settling and retard air flow through cavities</p> <p>Protect worker and occupant health</p>
PA WAP Guidance:	<p>Refer to PA WAP Health and Safety Plan.</p> <p>Remember to document lead-safe work practices in the Client File (photos).</p>	

Title	Specification(s)	Objective(s)
4.1101.1b Exterior dense pack	<p>Using fill tube, 100% of each cavity will be filled to a consistent density:</p> <ul style="list-style-type: none"> 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 per manufacturer's specifications <p>The number of bags installed will be confirmed and will match the number required on the coverage chart</p> <p>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</p>	<p>Eliminate voids and settling</p> <p>Minimize framing cavity air flows</p>
PA WAP Guidance:	See PA SWS Field Manual, Chapter 4: Insulation, section on Insulation Certificate for PA WAP guidance	

4.1101.2 Exterior Wall Insulating Sheathing

Topic: Walls

Subtopic: Preparation

Desired Outcome: Wall cladding removed and replaced to expose wall sheathing for installation of insulating wall sheathing

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

Title	Specification(s)	Objective(s)
4.1101.2a Wall cladding removal	<p>Existing cladding will be removed</p> <p>Lead and asbestos safety procedures will be followed</p>	<p>Expose existing wall sheathing to prepare for installation of insulating sheathing</p>
4.1101.2b Wall cladding replacement	<p>New cladding will be installed in accordance with manufacturer specifications and local codes after exterior wall insulation is installed</p>	<p>Install wall cladding correctly</p> <p>Meet local codes</p>

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

Topic: Walls

Subtopic: Preparation

Desired Outcome: Finished surfaces are protected and [SPF](#) has a suitable surface to adhere to

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

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

Desired Outcome: Outlet, junction, switch, and light fixture boxes and existing wiring are protected from [SPF](#)

For supporting material, see [Referenced Standards](#) and [General Information on Spray Polyurethane Foam \(SPF\)](#).

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

Subtopic 4.1102 Accessible Walls

4.1102.1 Open-Cavity Wall Insulation—General

Topic: Walls

Subtopic: Accessible Walls

Desired Outcome: Consistent, uniform [thermal boundary](#) between the conditioned space and unconditioned space to prescribed R-value

Title	Specification(s)	Objective(s)
4.1102.1a Sealing	Holes and penetrations will be sealed Bypasses will be blocked and sealed	Prevent air leakage



Before

Penetrations and bypasses create places where blown in insulation can leak



After

Sealed penetrations offer leakage protection and keep insulation in place

Tools:

1. caulk gun

Materials:

1. Backer rod
2. Spray foam
3. Caulk



Open walls to be insulated and drywalled need air sealing



Penetrations and bypasses should be sealed to keep insulation in cavities



Use backer rod or other infill for larger penetrations



Seal penetration with caulk or fireblock, as appropriate

Title	Specification(s)	Objective(s)
4.1102.1b Installation	<p>Insulation will be installed in accordance with manufacturer specifications without gaps, voids, compressions, misalignments, or wind intrusions</p> <p>Insulation will be installed to prescribed R-value</p>	Insulate to prescribed R-value



Before

Open walls should be insulated



After

Well-insulated rooms are significantly more comfortable in all seasons

Tools:

1. Insulation machine
2. Staple gun

Materials:

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



Wall should be netted and insulation blow in to prescribed r-value

OR: Wall can be insulated using faced fiberglass insulation installed without gaps



4.1102.1c Pre-drywall verification	Verification of complete installation without gaps, voids, compressions, misalignments, or wind intrusions will be provided	Install insulation correctly
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Take a visual and physical inspection of insulation installation. Verify insulation is properly installed before drywalling.



Title	Specification(s)	Objective(s)
4.1102.1d Occupant education	<p>A dated receipt signed by the installer will be provided that includes:</p> <ul style="list-style-type: none"> • Insulation type • Coverage area • R-value • Installed thickness and settled thickness (settled thickness required for loose-fill only) • Number of bags installed in accordance with manufacturer specifications (for loose-fill only) 	<p>Document job completion to contract specifications</p> <p>Confirm amount of insulation installed</p> <p>Comply with 16 CFR 460.17</p>
PA WAP Guidance:	See PA SWS Field Manual, Chapter 4: Insulation, section on Insulation Certificate for PA WAP guidance	



Best Practice

Provide occupant with documentation of and about insulation installed



Communicate professionally with occupant to provide information and support

Documentation should include insulation material and r-value



4.1102.2 Open-Cavity Wall—Spray Polyurethane Foam (SPF) Installation

Topic: Walls

Subtopic: Accessible Walls

Desired Outcome: Exterior walls are insulated and sealed

For supporting material, see [General Information on Spray Polyurethane Foam \(SPF\)](#) and [Referenced Standards](#).

Title	Specification(s)	Objective(s)
4.1102.2a Installation	<p>Interior cladding or interior finish material will be removed on areas to be insulated</p> <p><i>SPF</i> will be applied to desired thickness, using pass thickness maximum as indicated by manufacturer</p> <p><i>SPF</i> will be applied onto exterior sheathing or interior finish materials between studs and top/bottom plates</p>	<p>Insulate and seal exterior walls</p>
4.1102.2b Vapor retarders	<p>If <i>vapor retarder</i> is needed, it will be applied in proper location</p> <p>In colder climates (<i>IECC</i> Zones 5-8), the <i>SPF</i> used will be installed to a thickness of at least Class II <i>vapor retarder</i> or have at least Class II <i>vapor retarder</i> coating or covering in direct contact with the inside surface of the <i>SPF</i></p>	<p>Minimize water vapor condensation in walls</p>
4.1102.2c Fire protection	<p><i>SPF</i> 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)</p> <p>Check local codes for fire protection requirements</p>	<p>Provide necessary fire protection for combustible <i>SPF</i> insulation</p>
4.1102.2d Onsite documentation	<p>A dated receipt signed by the installer will be provided that includes:</p> <ul style="list-style-type: none"> • Coverage area • Thickness • R-value 	<p>Document job completion to contract specifications</p> <p>Confirm amount of insulation installed</p> <p>Comply with 16 CFR 460.17</p>
PA WAP Guidance:	See PA SWS Field Manual, Chapter 4: Insulation, section on Insulation Certificate for PA WAP guidance	

Subtopic 4.1103 Enclosed Walls

4.1103.1 Dense Pack Exterior Walls

Topic: Walls

Subtopic: Enclosed Walls

Desired Outcome: Consistent, uniform [thermal boundary](#) between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

For supporting material, see [Referenced Standards](#).

Title	Specification(s)	Objective(s)
4.1103.1a Exterior dense pack	<p>Using fill tube, 100% of each cavity will be filled to a consistent density:</p> <ul style="list-style-type: none">Cellulose insulation used in an enclosed cavity will be installed at 3.5 pounds per cubic foot or greater densityBlown 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 <i>cfm</i> /sq. ft. at 50 pascals, as measured using <i>BPI</i> -102 "Standard for Air Resistance of Thermal Insulation Used in Retrofit Cavity Applications – Material Specification" or <i>ASTM</i> 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 <p>Insulation will be verified to prevent visible air movement using chemical smoke at 50 pascals of pressure difference</p>	<p>Eliminate voids and settling</p> <p>Minimize framing cavity air flows</p>



Before

Make accurate count of insulation bags to be installed

Tools:

1. insulation blowing machine
2. pressure gauge
3. blower door
4. chemical smoke dispenser
5. drill
6. tape measure
7. ladder
8. utility flag bent into a "Z" shape



After

Install insulation to correct density (per manufacturer's instructions)

Materials:

1. cellulose or fiberglass insulation (any fiberglass material used must be specifically approved for air flow resistance by the manufacturer)
2. wooden, plastic, or foam plugs to fill installation holes
3. piece of fiberglass batt or towel to stop insulation from blowing out around the hose

Title	Specification(s)	Objective(s)
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4.1103.1a Exterior dense pack



1. Calculate the number of bags needed and verify the number you actually install



2. Check that the static pressure at the blowing machine and at the hose end is at least 2.9 PSI



3. Adjust the pressure with the blower controls



4. Adjust the feed gate to fill an 8-foot wall cavity in 2 to 4 minutes



5. With a rag or fiberglass batt to prevent insulation blowing out, fill all cavities in exterior walls with insulation



If you've blown for over four minutes without reaching proper density, find out where cellulose is going!



6. Check to make sure all cavities are properly filled. One of these is empty, and another is not filled to proper density

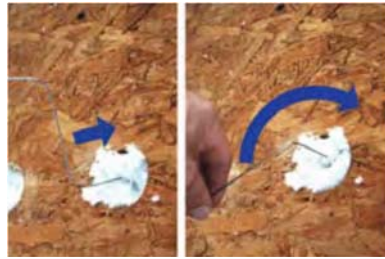
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Title	Specification(s)	Objective(s)
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4.1103.1a Exterior dense pack



7. Check that cavities are filled and are the proper density. Insert a bent utility flag into insulation.

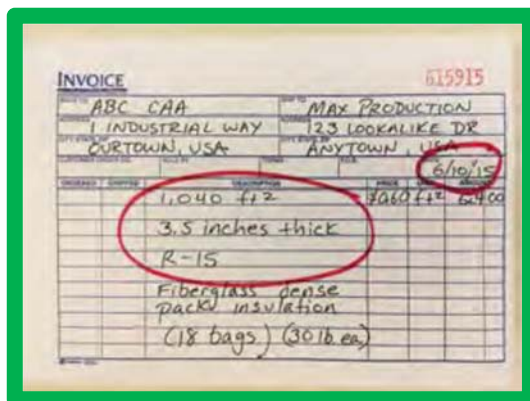


8. If it is possible to turn, the cavity needs more insulation.



9. Check for air leakage reduction after dense-pack insulation using a blower door at -50 Pascals and smoke

4.1103.1b Onsite documentation	<p>A dated receipt signed by the installer will be provided that includes:</p> <ul style="list-style-type: none"> • Coverage area • Thickness • R-value 	<p>Document job completion to contract specifications</p> <p>Confirm amount of insulation installed Comply with 16 CFR 460.17</p>
<p>PA WAP Guidance:</p>	<p>See PA SWS Field Manual, Chapter 4: Insulation, section on Insulation Certificate for PA WAP guidance</p>	



Best Practice

Provide occupant with documentation of and about insulation installed. Provide a dated insulation receipt showing coverage area, R-value, and thickness

4.1103.2 Additional Exterior Wall Cavities

Topic: Walls

Subtopic: Enclosed Walls

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

For supporting material, see [Calculation of the Infiltration Credit](#) and [Referenced Standards](#).

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



Before

Cavities missing insulation allow greater heat transfer than insulated ones. Either from inside or outside, use an IR camera to locate cavities for fill



In Progress

Drill appropriate size holes to prep for dense pack

Tools:

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

Title	Specification(s)	Objective(s)
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 <i>air barrier</i> is connected across all accessible house elements



Before

Unsealed penetrations should be sealed to ensure insulation stays in place

Tools:

1. Caulk gun



After

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

Materials:

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

Title	Specification(s)	Objective(s)
4.1103.2c Dense packing	<p>Using fill tube, 100% of each cavity will be filled to a consistent density:</p> <ul style="list-style-type: none"> 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 <i>cfm</i> /sq. ft. at 50 pascals, as measured using <i>BPI</i> -102 "Standard for Air Resistance of Thermal Insulation Used in Retrofit Cavity Applications—Material Specification" or <i>ASTM</i> 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 <p>Insulation will be verified to prevent visible air movement using chemical smoke at 50 pascals of pressure difference</p>	<p>Eliminate voids and settling</p> <p>Minimize framing cavity air flows</p>



Before

Make accurate count of insulation bags to be installed

Tools:

1. insulation blowing machine
2. pressure gauge
3. blower door
4. chemical smoke dispenser
5. drill
6. tape measure
7. ladder
8. utility flag bent into a "Z" shape



After

Install insulation to correct density (per manufacturer's instructions)

Materials:

1. cellulose or fiberglass insulation (any fiberglass material used must be specifically approved for air flow resistance by the manufacturer)
2. wooden, plastic, or foam plugs to fill installation holes
3. piece of fiberglass batt or towel to stop insulation from blowing out around the hose

Title	Specification(s)	Objective(s)
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4.1103.2c Exterior dense pack



1. Calculate the number of bags needed and verify the number you actually install



2. Check that the static pressure at the blowing machine and at the hose end is at least 2.9 PSI



3. Adjust the pressure with the blower controls



4. Adjust the feed gate to fill an 8-foot wall cavity in 2 to 4 minutes



5. With a rag or fiberglass batt to prevent insulation blowing out, fill all cavities in exterior walls with insulation



If you've blown for over four minutes without reaching proper density, find out where cellulose is going!



6. Check to make sure all cavities are properly filled. One of these is empty, and another is not filled to proper density

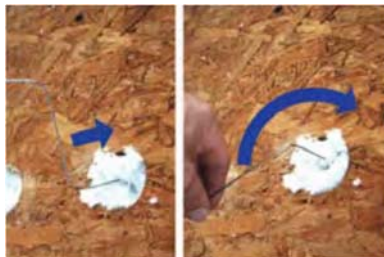
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Title	Specification(s)	Objective(s)
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4.1103.2c Exterior dense pack



7. Check that cavities are filled and are the proper density. Insert a bent utility flag into insulation.



8. If it is possible to turn, the cavity needs more insulation.



9. Check for air leakage reduction after dense-pack insulation using a blower door at -50 Pascals and smoke

Title	Specification(s)	Objective(s)
4.1103.2d Quality assurance	<p>Completed wall sections will be viewed using infrared camera with blower door operating</p> <p>Any voids or low density areas will be drilled and re-packed</p>	<p>Establish <i>air barrier</i> and <i>thermal boundary</i></p> <p>Confirm no voids or hidden air flows remain</p>



Before

Uninsulated exterior wall cavities to be insulated. Either from inside or outside, use an IR camera to locate cavities for fill



After

Reduced temperature difference indicating insulated wall cavities

Tools:

1. Infrared camera



Depressurize house (if safe) to -50pa wrt outside



Inspect for voids and low density areas



Reduced temperature difference indicating insulated wall cavities

Title	Specification(s)	Objective(s)
4.1103.2e Close holes	<p>Installation holes will be plugged as follows:</p> <ul style="list-style-type: none"> • Exterior holes will be weather barrier patched • Interior holes will be coated and patched to match original interior surface <p>All construction debris and dust will be collected and removed</p>	Ensure house is returned to watertight and clean condition



In Progress

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



After

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

Tools:

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

Materials:

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

Title	Specification(s)	Objective(s)
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4.1103.2e Close holes



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



2. Once drywall patches are spackled, prime and paint



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



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



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



6. If possible, maintain house wrap, or replace it after holes are plugged. Put siding back in place, or return exterior finish to match remaining wall

<p>4.1103.2f Onsite documentation</p>	<p>A dated receipt signed by the installer will be provided that includes:</p> <ul style="list-style-type: none"> • Coverage area • Thickness • R-value 	<p>Document job completion to contract specifications</p> <p>Confirm amount of insulation installed</p> <p>Comply with 16 CFR 460.17</p>
<p>PA WAP Guidance:</p>	<p>See PA SWS Field Manual, Chapter 4: Insulation, section on Insulation Certificate for PA WAP guidance</p>	

4.1103.3 Insulated Sheathing and Insulated Siding Installation

Topic: Walls

Subtopic: Enclosed Walls

Desired Outcome: Properly installed insulated wall sheathing and insulated siding

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	A dated receipt signed by the installer will be provided that includes: <ul style="list-style-type: none"> • Coverage area • Thickness • R-value 	Document job completion to contract specifications Confirm amount of insulation installed Comply with 16 CFR 460.17
PA WAP Guidance:	See PA SWS Field Manual, Chapter 4: Insulation, section on Insulation Certificate for PA WAP guidance	

Topic 4.13 Floors

Subtopic 4.1301 Accessible Floors

4.1301.1 Standard Floor System—Batt Installation

Topic: Floors

Subtopic: Accessible Floors

Desired Outcome: Consistent, uniform [thermal boundary](#) between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

Title	Specification(s)	Objective(s)
4.1301.1a Sealing	Sealing the floor system will be completed before insulating	Ensure airtight envelope Prevent leakage



Before

Gaps around penetrations can cause air leakage and negate insulation



After

Sealed penetrations maintain air barrier

Tools:

1. Caulk gun

Materials:

1. Caulk
2. Backer rod
3. Spray foam

Be alert to high-temperature flues and chimneys and use appropriate sealants and materials. See 3.1402.1c.



Locate gaps around penetrations for plumbing, electrical, etc.



Fill gaps greater than ¼ inch with backer rod or spray foam



Caulk smaller gaps and to hold backer rod in place

Title	Specification(s)	Objective(s)
4.1301.1b Installation	<p>Insulation will be installed in contact with subfloor without gaps, voids, compressions, misalignments, or wind intrusions</p> <p>If kraft-faced batts are used, they will be installed with kraft facing to subfloor</p> <p>Insulation will be installed to prescribed R-value</p>	Insulate to prescribed R-value



Before

Uninsulated floors above unconditioned spaces are an energy drain



After

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

Tools:

1. Utility knife
2. Tape measure

Materials:

1. Kraft-faced fiberglass batts to work order specifications

Measures		Components P.1			
Measure 8: Floor Ins. R-11		Comment			
Comment		Estimated			
R. Material / Labor		Description / Comment	Units	Qty	Unit Cost
1. Insulation		Floor Insulation - Kraft-faced Batts - R-11	SqFt	1100	\$0.22
2. Labor		Floor Insulation - Kraft-faced Batts - R-11	SqFt	1100	\$0.35
3. Miscellaneous Ss		Floor Insulation - Kraft-faced Batts - R-11	Each	1	\$100.00

Order and install insulation as called for in Work Order



If precise r-value cannot be purchased, choose option with greater r-value



Install kraft-faced batts with paper facing against subfloor



Ensure batts are in full contact with subfloor and remain uncompressed

Title	Specification(s)	Objective(s)
4.1301.1c Securing batts	Batts will be secured with physical fasteners	Ensure insulation remains in contact with subfloor



Before

Fiberglass batts should not be hanging away from subfloor

Tools:

1. Utility knife
2. Drill
3. Staple gun



After

Insulation supports or twine can be used to hold batts in contact

Materials:

1. Insulation supports
2. Twine
3. Fasteners



Ensure batts are in full contact with subfloor and remain uncompressed



Twine fastened across bays in a zig-zag pattern can also be used

4.1301.1d Occupant education	<p>A dated receipt signed by the installer will be provided that includes:</p> <ul style="list-style-type: none"> • Coverage area • Thickness • R-value 	<p>Document job completion to contract specifications</p> <p>Confirm amount of insulation installed</p> <p>Comply with 16 CFR 460.17</p>
PA WAP Guidance:	See PA SWS Field Manual, Chapter 4: Insulation, section on Insulation Certificate for PA WAP guidance	

4.1301.2 Standard Floor System—Loose Fill with Netting

Topic: Floors

Subtopic: Accessible Floors

Desired Outcome: Consistent, uniform [thermal boundary](#) between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

Title	Specification(s)	Objective(s)
4.1301.2a Sealing	Sealing the floor system will be completed before insulating	Ensure airtight envelope Prevent leakage



Before

Gaps around penetrations can cause air leakage and negate insulation



After

Sealed penetrations maintain air barrier

Tools:

1. Caulk gun

Materials:

1. Caulk
2. Backer rod
3. Spray foam

Be alert to high-temperature flues and chimneys and use appropriate sealants and materials. See 3.1402.1c.



Locate gaps around penetrations for plumbing, electrical, etc.



Fill gaps greater than ¼ inch with backer rod or spray foam



Caulk smaller gaps and to hold backer rod in place

Title	Specification(s)	Objective(s)
4.1301.2b Netting, fabric	<p>When using netting or fabric, staples will be placed according to manufacturer specifications</p> <p>Netting or fabric will meet local fire codes</p>	Secure insulation



Before

Uninsulated floors above unconditioned spaces are an energy drain



In Progress

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

Tools:

1. Utility knife
2. Scissors
3. Stapler

Materials:

1. Fabric netting
2. Staples



Secure netting across each joist to create separate cavities



Secure netting across sills to prevent leakage of insulation



Keep netting taut while stapling to prevent wrinkles and leakage

Staples should be kept tightly together, placed no more than 1-1/2" apart



Title	Specification(s)	Objective(s)
4.1301.2c Installation	<p>Insulation in netted or fabric cavities will be dense packed with loose fill insulation in accordance with manufacturer specifications</p> <p>Insulation will be installed to prescribed R-value</p> <p>Insulation will be in continuous contact with <i>air barrier</i></p>	<p>Insulate to prescribed R-value</p> <p>Ensure a continuous <i>thermal boundary</i> between conditioned and unconditioned space</p>



In Progress

With netting in place, insulation can begin



After

Cavities filled to manufacturer specs to achieve prescribed r-value

Tools:

1. Utility knife
2. Insulation machine

Materials:

1. Loose fill fiberglass or cellulose

Measures							
Measure 7 Floor Ins. R30		Components P1					
Comment		Estimated					
#	Material / Labor	Description / Comment	Units	Qty	Unit Cost	Total	OR
1	Insulation	Floor Insulation - Net & FIB - R30	SqY	1100	\$0.55	\$605.00	
2	Labor	Floor Insulation - Net & FIB - R30	SqY	1100	\$0.35	\$385.00	
3	Measurement Sq	Floor Insulation - Net & FIB - R30	Each	1	\$100.00	\$100.00	

1. Order and install insulation based on specifications in work order



2. Always wear proper PPE when blowing insulation



3. Cut holes in each individual cavity to insert insulation machine nozzle. Ensure that hold is large enough for nozzle without allowing for outflow



4. Consult manufacturer specs on insulation packaging for proper installation



5. Blow in insulation to prescribed r-value

Title	Specification(s)	Objective(s)
4.1301.2d Occupant education	<p>A dated receipt signed by the installer will be provided that includes:</p> <ul style="list-style-type: none"> • Insulation type • Coverage area • R-value • Installed thickness and minimum settled thickness • Number of bags installed in accordance with manufacturer specifications 	<p>Document job completion to contract specifications</p> <p>Confirm amount of insulation installed</p> <p>Ensure ability to match bags required for total area completed</p> <p>Comply with 16 CFR 460.17</p>
PA WAP Guidance:	See PA SWS Field Manual, Chapter 4: Insulation, section on Insulation Certificate for PA WAP guidance	



Best Practice

Provide occupant with documentation of and about insulation installed



Communicate professionally with occupant to provide information and support



Documentation should include insulation material and r-value

4.1301.3 Standard Floor System—Loose Fill with Rigid Barrier

Topic: Floors

Subtopic: Accessible Floors

Desired Outcome: Consistent, uniform [thermal boundary](#) between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

Title	Specification(s)	Objective(s)
4.1301.3a Sealing	Sealing the floor system will be completed before insulating	Ensure airtight envelope Prevent leakage



Before

Gaps around penetrations can cause air leakage and negate insulation



After

Sealed penetrations maintain air barrier

Tools:

1. Caulk gun

Materials:

1. Caulk
2. Backer rod
3. Spray foam

Be alert to high-temperature flues and chimneys and use appropriate sealants and materials. See 3.1402.1c.



Locate gaps around penetrations for plumbing, electrical, etc.



Fill gaps greater than ¼ inch with backer rod or spray foam



Caulk smaller gaps and to hold backer rod in place

Title	Specification(s)	Objective(s)
4.1301.3b Rigid air barrier	<p>A rigid <i>air barrier</i> will be mechanically fastened to underside of floor assembly, providing 100% coverage of the floor assembly</p> <p>Seams and penetrations will be sealed</p>	Relocate <i>air barrier</i>



Before

Uninsulated floors above unconditioned spaces are an energy drain

Tools:

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



After

Rigid barriers provide air sealing and create cavities for insulation

Materials:

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



Attach barrier to joists using appropriate fasteners for chosen material



When possible, align seams with joist. Seal all seams with caulk



Pay particular attention to sealing at complex joints to prevent leakage



Remember to seal along sills as well

Title	Specification(s)	Objective(s)
4.1301.3c Installation	<p>Loose fill insulation will be installed between <i>air barrier</i> and subfloor according to manufacturer specifications</p> <p>Insulation will be installed to prescribed R-value</p>	Insulate to prescribed R-value



Before

Once rigid barrier is sealed, insulation can be blown in

Tools:

1. Insulation machine
2. Caulk gun



After

Materials:

1. Loose fill insulation
2. Caulk

Title	Specification(s)	Objective(s)
4.1301.3d Occupant education	<p>A dated receipt signed by the installer will be provided that includes:</p> <ul style="list-style-type: none"> • Insulation type • Coverage area • R-value • Installed thickness and minimum settled thickness • Number of bags installed in accordance with manufacturer specifications 	<p>Document job completion to contract specifications</p> <p>Confirm amount of insulation installed</p> <p>Ensure ability to match bags required for total area completed</p> <p>Comply with 16 CFR 460.17</p>
PA WAP Guidance:	See PA SWS Field Manual, Chapter 4: Insulation, section on Insulation Certificate for PA WAP guidance	



Best Practice

Provide occupant with documentation of and about insulation installed



Communicate professionally with occupant to provide information and support

Documentation should include insulation material and r-value



4.1301.4 Dense Pack Floor System with Rigid Barrier

Topic: Floors

Subtopic: Accessible Floors

Desired Outcome: Consistent, uniform [thermal boundary](#) between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

Title	Specification(s)	Objective(s)
4.1301.4a Sealing	Sealing the floor system will be completed before insulating	Ensure airtight envelope Prevent leakage



Before

Gaps around penetrations can cause air leakage and negate insulation



After

Sealed penetrations maintain air barrier

Tools:

1. Caulk gun

Materials:

1. Caulk
2. Backer rod
3. Spray foam

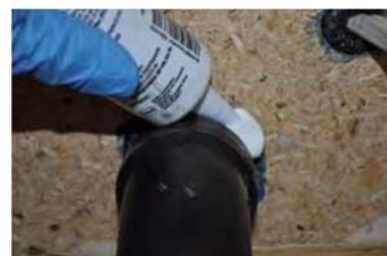
Be alert to high-temperature flues and chimneys and use appropriate sealants and materials. See 3.1402.1c.



Locate gaps around penetrations for plumbing, electrical, etc.



Fill gaps greater than ¼ inch with backer rod or spray foam



Caulk smaller gaps and to hold backer rod in place

Title	Specification(s)	Objective(s)
4.1301.4b Rigid air barrier	A rigid <i>air barrier</i> will be mechanically fastened to underside of floor assembly, providing 100% coverage of the floor assembly Seams and penetrations will be sealed	Relocate <i>air barrier</i>



Before

Uninsulated floors above unconditioned spaces are an energy drain

Tools:

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



After

Rigid barriers provide air sealing and create cavities for insulation

Materials:

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



Securely fasten rigid barrier, aligning seams with joist when possible



Seal all seams with caulk to prevent leakage



Pay particular attention to sealing at complex joints to prevent leakage



Remember to seal along sills as well

Title	Specification(s)	Objective(s)
4.1301.4c Installation	<p><i>Dense pack</i> insulation will be installed between <i>air barrier</i> and subfloor according to manufacturer specifications</p> <p>Insulation will be installed to prescribed R-value</p>	Insulate to prescribed R-value



Before

Once rigid barrier is sealed, insulation can be blown in

Tools:

1. Insulation machine
2. Caulk gun



After

Rigid barrier should be resealed to maintain air barrier after filling

Materials:

1. Loose fill insulation
2. Caulk

Title	Specification(s)	Objective(s)
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4.1301.4c Installation



Make sure to wear proper PPE when working with insulation

Measure 1 Floor Ins. R-30						
Components F1						
Comment						
Estimated						
#	Material - Labor	Description - Comment	Units	Qty	Unit Cost	Total
1	Insulation	Floor Insulation - Net & F&I - R-30	SqFt	1100	\$0.35	\$385.00
2	Labor	Floor Insulation - Net & F&I - R-30	SqFt	1100	\$0.35	\$385.00
3	Manufacturing Sq	Floor Insulation - Net & F&I - R-30	Each	1	\$100.00	\$100.00

Purchase and install loose fill to r-value specified on Work Order

MINIMUM BAG COMPRESS LIMIT FOR CORNER CARRY APPLICATIONS					
Insulation Material	Density (lb/ft³)	Compressed Density (lb/ft³)	Minimum Weight per Bag	Number of Bags per 1,000 Sq Ft	Minimum Coverage per Bag
1.5" Polystyrene	1.5	1.2	1.2	170	27.1
2.0" Polystyrene	2.0	1.6	1.6	130	20.4
2.5" Polystyrene	2.5	2.0	2.0	100	15.3
3.0" Polystyrene	3.0	2.4	2.4	80	12.5
3.5" Polystyrene	3.5	2.8	2.8	65	10.2
4.0" Polystyrene	4.0	3.2	3.2	55	8.6
4.5" Polystyrene	4.5	3.6	3.6	45	7.0
5.0" Polystyrene	5.0	4.0	4.0	35	5.4
5.5" Polystyrene	5.5	4.4	4.4	30	4.6
6.0" Polystyrene	6.0	4.8	4.8	25	3.8

Check manufacturer specifications for proper density to reach r-value



Drill hole slightly larger than nozzle into rigid barrier with hole saw



Dense pack insulation into floor cavities



When filled to specified density and r-value, fill access hole



Plug access hole and seal to maintain air barrier

Title	Specification(s)	Objective(s)
4.1301.4d Occupant education	<p>A dated receipt signed by the installer will be provided that includes:</p> <ul style="list-style-type: none"> • Coverage area • Thickness • R-value 	<p>Document job completion to contract specifications</p> <p>Confirm amount of insulation installed</p> <p>Comply with 16 CFR 460.17</p>
PA WAP Guidance:	See PA SWS Field Manual, Chapter 4: Insulation, section on Insulation Certificate for PA WAP guidance	



Best Practice

Provide occupant with documentation of and about insulation installed



Communicate professionally with occupant to provide information and support

Documentation should include insulation material and r-value



4.1301.5 Cantilevered Floor—Batt Installation

Topic: Floors

Subtopic: Accessible Floors

Desired Outcome: Consistent, uniform [thermal boundary](#) between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

Title	Specification(s)	Objective(s)
4.1301.5a Air barrier	<p><i>Air barrier</i> will be installed between joists and sealed</p> <p><i>Air barrier</i> will be placed to the most interior edge of the top plate of the wall below</p>	<p>Separate cantilevered floor from conditioned floor space</p> <p>Allow for insulation</p>



Before

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

Tools:

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



After

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

Materials:

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

1. Stuff the cavities with fiberglass insulation as a backer, and then apply two-part spray polyurethane foam to seal the openings.
2. Cut and install drywall, plywood, OSB, or rigid foam board in each cavity, then seal around the edges with foam or caulk.
3. Install dense-pack insulation in cantilevered area, being careful to extend it inward past the supporting wall (this also accomplishes insulating the cantilevered floor area).

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

Title	Specification(s)	Objective(s)
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4.1301.5a Air barrier



1. Measure cavity to determine size necessary for blocking



2. Measure and cut blocking to fit snugly between floor joists



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



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



5. Cut batt insulation to match the size of the blocking

Title	Specification(s)	Objective(s)
4.1301.5b Installation	<p><i>Air barrier</i> will be insulated between joist from top plate of the wall below to subfloor above</p> <p>Cantilevered subfloor will be insulated in complete contact with the floor without gaps, voids, compressions, misalignments, or wind intrusions</p> <p>If kraft-faced batts are used, they will be installed with kraft facing to the <i>air barrier</i></p> <p>Insulation will be installed to prescribed R-value</p>	Insulate to prescribed R-value



Before

Cavities are open and subfloor of conditioned space above is uninsulated

Tools:

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



After

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

Materials:

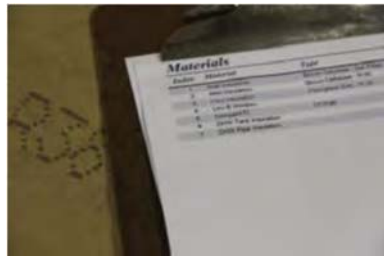
1. batt insulation - kraft-faced or unfaced
2. insulation supports

Title	Specification(s)	Objective(s)
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4.1301.5b Installation



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



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



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



4. Ensure the batt is positioned correctly



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

Title	Specification(s)	Objective(s)
4.1301.5c Attachment	Batts will be secured with physical fasteners	Ensure insulation remains in contact with subfloor and <i>air barrier</i>



Before

Fiberglass batts should not be hanging away from subfloor

Tools:

1. Utility knife
2. Drill
3. Staple gun



After

Insulation supports or twine can be used to hold batts in contact

Materials:

1. Insulation supports
2. Twine
3. Fasteners



Ensure batts are in full contact with subfloor and remain uncompressed



Twine fastened across bays in a zig-zag pattern can also be used

Title	Specification(s)	Objective(s)
4.1301.5d Exterior soffit	Exterior soffit material will be installed and sealed	Cover and protect insulation



Before

Cavities have been insulated but are still exposed.

Tools:

1. claw hammer
2. drill
3. mechanical fasteners



After

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

Materials:

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



- 1.** Cantilevered floors should be insulated to preserve thermal boundary



- 2.** Seal off floor cavities using previously removed materials, in the case OSB and vinyl soffit



- 3.** Re-install any materials that were removed, such as OSB, J-channels, and vinyl soffit



- 4.** Completed installation

Title	Specification(s)	Objective(s)
4.1301.5e Occupant education	<p>A dated receipt signed by the installer will be provided that includes:</p> <ul style="list-style-type: none"> • Coverage area • Thickness • R-value 	<p>Document job completion to contract specifications</p> <p>Confirm amount of insulation installed</p> <p>Comply with 16 CFR 460.17</p>
PA WAP Guidance:	See PA SWS Field Manual, Chapter 4: Insulation, section on Insulation Certificate for PA WAP guidance	



Best Practice

Provide occupant with documentation of and about insulation installed



Communicate professionally with occupant to provide information and support

Documentation should include insulation material and r-value



4.1301.6 Pier Construction Subfloor Insulation—Batt Installation with Rigid Barrier

Topic: Floors

Subtopic: Accessible Floors

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

Title	Specification(s)	Objective(s)
4.1301.6a Subfloor preparation	Sealing between house and crawl space will be completed before insulating	Ensure airtight <i>envelope</i> Prevent leakage



Before

Gaps around penetrations can cause air leakage and negate insulation



After

Sealed penetrations maintain air barrier

Tools:

1. Caulk gun

Materials:

1. Caulk
2. Backer rod
3. Spray foam

Be alert to high-temperature flues and chimneys and use appropriate sealants and materials. See 3.1402.1c.



Locate gaps around penetrations for plumbing, electrical, etc.



Fill gaps greater than ¼ inch with backer rod or spray foam



Caulk smaller gaps and to hold backer rod in place

Title	Specification(s)	Objective(s)
4.1301.6b Installation	<p>Insulation will be installed in contact with subfloor without gaps, voids, compressions, misalignments, or wind intrusions</p> <p>If kraft-faced batts are used, they will be installed with kraft facing to subfloor</p> <p>Insulation will be installed to prescribed R-value</p>	Insulate to prescribed R-value



Before

Uninsulated floors above unconditioned spaces are an energy drain



After

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

Tools:

1. Utility knife
2. Drill

Materials:

1. Kraft-faced fiberglass batts to work order specifications
2. Rigid barrier -- drywall, plywood, XPS
3. Fasteners

Measures				Components F1			
Measure #	Flux In. R-11	Comment	Unit	Qty	Unit Cost	Total	Q6
1	Insulation	Floor Insulation - Kraft-Faced Batts - R-11	SqFt	1100	\$0.22	\$242.00	
2	Labor	Floor Insulation - Kraft-Faced Batts - R-11	SqFt	1100	\$0.35	\$385.00	
3	Miscellaneous Su	Floor Insulation - Kraft-Faced Batts - R-11	Each	1	\$100.00	\$100.00	

Order and install insulation as called for in Work Order



If precise r-value cannot be purchased, choose option with greater r-value



Install kraft-faced batts with paper facing against subfloor



Ensure batts are in full contact with subfloor and remain uncompressed

Title	Specification(s)	Objective(s)
4.1301.6c Secure batts	Batts will be secured with physical fasteners	Ensure insulation remains in contact with subfloor



Before

Fiberglass batts should not be hanging away from subfloor

Tools:

1. Utility knife
2. Drill
3. Staple gun



After

Insulation supports or twine can be used to hold batts in contact

Materials:

1. Insulation supports
2. Twine
3. Fasteners



Ensure batts are in full contact with subfloor and remain uncompressed



Twine fastened across bays in a zig-zag pattern can also be used

Title	Specification(s)	Objective(s)
4.1301.6d Rigid air barrier	<p>A rigid <i>air barrier</i> will be mechanically fastened to underside of floor assembly</p> <p>Seams and penetrations will be sealed</p>	Protect insulation



Before

Unfaced fiberglass batts can be attractive housing for pests

Tools:

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



After

Rigid barrier allows for air sealing and protects batt insulation

Materials:

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



Securely fasten rigid barrier, aligning seams with joist when possible



Seal all seams with caulk to prevent leakage



Pay particular attention to sealing at complex joints to prevent leakage



Remember to seal along sills as well

Title	Specification(s)	Objective(s)
4.1301.6e Occupant education	<p>A dated receipt signed by the installer will be provided that includes:</p> <ul style="list-style-type: none"> • Coverage area • Thickness • R-value 	<p>Document job completion to contract specifications</p> <p>Confirm amount of insulation installed</p> <p>Comply with 16 CFR 460.17</p>
PA WAP Guidance:	See PA SWS Field Manual, Chapter 4: Insulation, section on Insulation Certificate for PA WAP guidance	



Best Practice

Provide occupant with documentation of and about insulation installed



Communicate professionally with occupant to provide information and support

Documentation should include insulation material and r-value



4.1301.7 Pier Construction Subfloor Insulation—Loose Fill with Rigid Barrier

Topic: Floors

Subtopic: Accessible Floors

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

Title	Specification(s)	Objective(s)
4.1301.7a Subfloor preparation	Sealing between house and crawl space will be completed before insulating	Prevent air leakage



Before

Gaps around penetrations can cause air leakage and negate insulation



After

Sealed penetrations maintain air barrier

Tools:

1. Caulk gun

Materials:

1. Caulk
2. Backer rod
3. Spray foam

Be alert to high-temperature flues and chimneys and use appropriate sealants and materials. See 3.1402.1c.



Locate gaps around penetrations for plumbing, electrical, etc.



Fill gaps greater than $\frac{1}{4}$ inch with backer rod or spray foam



Caulk smaller gaps and to hold backer rod in place

Title	Specification(s)	Objective(s)
4.1301.7b Rigid air barrier	<p>A rigid <i>air barrier</i> will be mechanically fastened to underside of floor assembly, providing 100% coverage of the floor assembly</p> <p>Seams and penetrations will be sealed</p>	Relocate <i>air barrier</i>



Before

Uninsulated floors above unconditioned spaces are an energy drain

Tools:

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



After

Rigid barriers provide air sealing and create cavities for insulation

Materials:

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



Attach barrier to joists using appropriate fasteners for chosen material



When possible, align seams with joist. Seal all seams with caulk



Pay particular attention to sealing at complex joints to prevent leakage



Remember to seal along sills as well

Title	Specification(s)	Objective(s)
4.1301.7c Installation	<p>Loose fill insulation will be installed between <i>air barrier</i> and subfloor according to manufacturer specifications</p> <p>Insulation will be installed to prescribed R-value</p>	Insulate to prescribed R-value



Before

Once rigid barrier is sealed, insulation can be blown in

Tools:

1. Insulation machine
2. Caulk gun



After

After insulating, restore rigid barrier to prevent leakage

Materials:

1. Loose fill insulation
2. Caulk

Title	Specification(s)	Objective(s)
4.1301.7d Occupant education	<p>A dated receipt signed by the installer will be provided that includes:</p> <ul style="list-style-type: none"> • Insulation type • Coverage area • R-value • Installed thickness and minimum settled thickness • Number of bags installed in accordance with manufacturer specifications 	<p>Document job completion to contract specifications</p> <p>Confirm amount of insulation installed</p> <p>Ensure ability to match bags required for total area completed</p> <p>Comply with 16 CFR 460.17</p>
PA WAP Guidance:	See PA SWS Field Manual, Chapter 4: Insulation, section on Insulation Certificate for PA WAP guidance	



Best Practice

Provide occupant with documentation of and about insulation installed



Communicate professionally with occupant to provide information and support



Documentation should include insulation material and r-value

4.1301.8 Pier Construction Subfloor Installation—Dense Pack with Rigid Barrier

Topic: Floors

Subtopic: Accessible Floors

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

Title	Specification(s)	Objective(s)
4.1301.8a Subfloor preparation	Sealing between house and crawl space will be completed before insulating	Prevent air leakage



Before

Gaps around penetrations can cause air leakage and negate insulation



After

Sealed penetrations maintain air barrier

Tools:

1. Caulk gun

Materials:

1. Caulk
2. Backer rod
3. Spray foam

Be alert to high-temperature flues and chimneys and use appropriate sealants and materials. See 3.1402.1c.



Locate gaps around penetrations for plumbing, electrical, etc.



Fill gaps greater than $\frac{1}{4}$ inch with backer rod or spray foam



Caulk smaller gaps and to hold backer rod in place

Title	Specification(s)	Objective(s)
4.1301.8b Rigid air barrier	<p>A rigid <i>air barrier</i> will be mechanically fastened to underside of floor assembly, providing 100% coverage of the floor assembly</p> <p>Seams and penetrations will be sealed</p>	Relocate <i>air barrier</i>



Before

Uninsulated floors above unconditioned spaces are an energy drain

Tools:

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



After

Rigid barriers provide air sealing and create cavities for insulation

Materials:

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



Attach barrier to joists using appropriate fasteners for chosen material



When possible, align seams with joist. Seal all seams with caulk



Pay particular attention to sealing at complex joints to prevent leakage



Remember to seal along sills as well

Title	Specification(s)	Objective(s)
4.1301.8c Installation	<p><i>Dense pack</i> insulation will be installed between <i>air barrier</i> and subfloor according to manufacturer specifications</p> <p>Insulation will be installed to prescribed R-value</p>	Insulate to prescribed R-value



Before

Once rigid barrier is sealed, insulation can be blown in

Tools:

1. Insulation machine
2. Caulk gun



After

Rigid barrier should be resealed to maintain air barrier after filling

Materials:

1. Loose fill insulation
2. Caulk

Title	Specification(s)	Objective(s)
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4.1301.8c Installation



Make sure to wear proper PPE when working with insulation

Measures						
Measure 1 Floor Ins. R-30						
Components F1						
Comment						
Estimated						
#	Material - Labor	Description - Comment	Units	Qty	Unit Cost	Total
1	Insulation	Floor Insulation - Net & Fill - R-30	SqFt	1100	\$0.50	\$550.00
2	Labor	Floor Insulation - Net & Fill - R-30	SqFt	1100	\$0.35	\$385.00
3	Maintenance Fee	Floor Insulation - Net & Fill - R-30	Each	1	\$100.00	\$100.00

Purchase and install loose fill to r-value specified on Work Order

MINIMUM BAG WEIGHTS FOR COMBINED CARRY APPLICATIONS					
Insulation Thickness	Density (lb/ft³)	Insulation Thickness	Minimum Weight per Bag	Number of Bags per 1,000 Sq Ft	Minimum Coverage per Bag
4.0"	2.0	4.0"	1.0	100	27.7
6.0"	2.0	6.0"	1.5	67	41.1
8.0"	2.0	8.0"	2.0	50	54.4
10.0"	2.0	10.0"	2.5	40	68.9
12.0"	2.0	12.0"	3.0	33	83.3
14.0"	2.0	14.0"	3.5	29	96.8
16.0"	2.0	16.0"	4.0	25	108.9
18.0"	2.0	18.0"	4.5	22	121.1
20.0"	2.0	20.0"	5.0	20	133.3
22.0"	2.0	22.0"	5.5	18	145.6
24.0"	2.0	24.0"	6.0	17	157.8
26.0"	2.0	26.0"	6.5	16	169.9
28.0"	2.0	28.0"	7.0	14	181.1
30.0"	2.0	30.0"	7.5	13	193.3

Check manufacturer specifications to install properly



Drill hole in rigid barrier slightly larger than insulation hose



Blown in insulation to density and r-value specified by work order



Once cavity is filled, prepare plug to reseat rigid barrier



Securely seal plug into rigid barrier to prevent leakage

Title	Specification(s)	Objective(s)
4.1301.8d Occupant education	<p>A dated receipt signed by the installer will be provided that includes:</p> <ul style="list-style-type: none"> • Coverage area • Thickness • R-value 	<p>Document job completion to contract specifications</p> <p>Confirm amount of insulation installed</p> <p>Comply with 16 CFR 460.17</p>
PA WAP Guidance:	See PA SWS Field Manual, Chapter 4: Insulation, section on Insulation Certificate for PA WAP guidance	



Best Practice

Provide occupant with documentation of and about insulation installed



Communicate professionally with occupant to provide information and support

Documentation should include insulation material and r-value



4.1301.9 Open Floors Over Unconditioned Space and Cantilevered Floors, Floors Over Garages, Floors Over Unconditioned Crawl Spaces—Spray Polyurethane

Topic: Floors

Subtopic: Accessible Floors

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

For supporting material, see [Calculation of the Infiltration Credit](#) and [Referenced Standards](#).

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

Title	Specification(s)	Objective(s)
4.1301.9d Onsite documentation	<p>A dated receipt signed by the installer will be provided that includes:</p> <ul style="list-style-type: none"> • Coverage area • Thickness • R-value 	<p>Document job completion to contract specifications</p> <p>Confirm amount of insulation installed</p> <p>Comply with 16 CFR 460.17</p>
PA WAP Guidance:	See PA SWS Field Manual, Chapter 4: Insulation, section on Insulation Certificate for PA WAP guidance	

Topic 4.14 Basements and Crawl Spaces

Subtopic 4.1401 Band/Rim Joists

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

Topic: Basements and Crawl Spaces

Subtopic: Band/Rim Joists

Desired Outcome: Insulate and seal all band/rim joist areas between subfloor and foundation or top plate of wall below

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

Title	Specification(s)	Objective(s)
4.1401.1a Preparation	All band/rim joist areas will be open and accessible for <i>SPF</i> application All surfaces where <i>SPF</i> 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 <i>SPF</i>
4.1401.1b Installation	<i>SPF</i> 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, <i>SPF</i> 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, <i>SPF</i> 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 <i>SPF</i> exceeds a thickness of 3", all <i>SPF</i> 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 <i>SPF</i> insulation

Title	Specification(s)	Objective(s)
4.1401.1d Onsite documentation	<p>A dated receipt signed by the installer will be provided that includes:</p> <ul style="list-style-type: none"> • Coverage area • Thickness • R-value 	<p>Document job completion to contract specifications</p> <p>Confirm amount of insulation installed</p> <p>Comply with 16 CFR 460.17</p>
PA WAP Guidance:	See PA SWS Field Manual, Chapter 4: Insulation, section on Insulation Certificate for PA WAP guidance	

4.1401.2 Band/Rim Joists – Insulation other than Spray Polyurethane Foam

Topic: Basements and Crawl Spaces
Subtopic: Band/Rim Joists

Desired Outcome: Closed crawl spaces insulated to achieve best thermal performance possible

Title	Specification(s)	Objective(s)
4.1401.2a Preparation	The rim joist, sill plate and adjacent surfaces will be sufficiently clean and free of debris to allow for the proper adhesion of any caulks, adhesives or spray foam used during installation.	Prepare all surfaces for the installation of insulation
4.1401.2b Insulation installation	<p>A foam-based insulation will be installed so as to create a continuous thermal and pressure boundary.</p> <p>If rigid insulation is used, all edges will be sealed and the insulation will be installed tightly to the wood to prevent the movement of moisture throughout the assembly.</p> <p>Insulation will be installed in accordance with local/national code requirements and/or manufacturer's instructions regarding flame spread.</p>	<p>Improve thermal performance</p> <p>Prevent moisture condensation on the inside of the band joist</p>
4.1401.2c Onsite documentation	<p>A dated receipt signed by the installer will be provided that includes:</p> <ul style="list-style-type: none"> • Coverage area • Thickness • R-value 	<p>Document job completion to contract specifications</p> <p>Confirm amount of insulation installed</p> <p>Comply with 16 CFR 460.17</p>
PA WAP Guidance:	See PA SWS Field Manual, Chapter 4: Insulation, section on Insulation Certificate for PA WAP guidance	

Subtopic 4.1402 Basements and Crawl Space Walls

4.1402.1 Closed Crawl Spaces—Wall Insulation

Topic: Basements and Crawl Spaces

Subtopic: Basements and Crawl Space Walls

Desired Outcome: Closed crawl spaces insulated to achieve best thermal performance possible

For supporting material, see [Calculation of the Infiltration Credit](#) and [Referenced Standards](#).

Title	Specification(s)	Objective(s)
4.1402.1a Insulation selection	A non fibrous, fire-rated Class I insulation will be used with a minimum life expectancy of 10 years	Provide fire-safe durable insulation
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	Prevent insulation from detaching from the foundation wall
4.1402.1g Onsite documentation	<p>A dated receipt signed by the installer will be provided that includes:</p> <ul style="list-style-type: none"> • Coverage area • Thickness • R-value 	<p>Document job completion to contract specifications</p> <p>Confirm amount of insulation installed</p> <p>Comply with 16 CFR 460.17</p>
PA WAP Guidance:	See PA SWS Field Manual, Chapter 4: Insulation, section on Insulation Certificate for PA WAP guidance	

4.1402.2 Basement Wall Insulation—No Groundwater Leakage

Topic: Basements and Crawl Spaces

Subtopic: Basements and Crawl Space Walls

Desired Outcome: Basement insulation improves thermal performance and ensures sufficient drying potential

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

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

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

Best Practice

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

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
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Before

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

Tools:

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



After

Insulation and drywall create an air barrier

Materials:

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

Title	Specification(s)	Objective(s)
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4.1402.2b Air barrier



XPS insulation board is a nonabsorbent insulation option



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



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



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

4.1402.2c Vapor permeability	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
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Before

Kraft-faced fiberglass insulation is absorbent



After

Drywall typically has a perm rating of 50-- good for zones 1-6

Title	Specification(s)	Objective(s)
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4.1402.2c Vapor permeability

Tools:

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

Materials:

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

The higher a material's perm rating, the more vapor can pass through said material. Drywall typically has a perm rating of approximately 50.

For vapor retarders in basements and crawl spaces, SWS calls for materials with a perm rating of <0.5 (which translates to 4mil or thicker). From 2007 IRC definition of vapor retarders:

Class I: ≤ 0.1 perm (called impermeable),

Class II: 0.1 to 1.0 perm (called semi-impermeable),

Class III: 1.0 perm to 10 perms (called semi-permeable).



Determine in which zone you are working before selecting work materials



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

4.1402.3 Basement Wall Insulation—Groundwater Leakage

Topic: Basements and Crawl Spaces

Subtopic: Basements and Crawl Space Walls

Desired Outcome: Basement insulation improves thermal performance and ensures sufficient drying potential

For supporting material, see [Calculation of the Infiltration Credit](#) and [Referenced Standards](#).

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
PA WAP Guidance:	See PA WAP Health and Safety Plan. PA WAP has limited funds for Health & Safety for moisture drainage. Consider deferral under these conditions.	
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

Title	Specification(s)	Objective(s)
4.1402.3g R-value	Regional <i>IECC</i> will be followed for required R-value	Improve thermal performance of the basement and living space
4.1402.3h Sealing	A continuous <i>air barrier</i> on the warm side of the <i>thermal boundary</i> 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 <i>IRC</i> will be followed for finished wall details in basements	Install a durable, finished wall
4.1402.3j Onsite documentation	<p>A dated receipt signed by the installer will be provided that includes:</p> <ul style="list-style-type: none"> • Coverage area • Thickness • R-value 	<p>Document job completion to contract specifications</p> <p>Confirm amount of insulation installed</p> <p>Comply with 16 CFR 460.17</p>
PA WAP Guidance:	See PA SWS Field Manual, Chapter 4: Insulation, section on Insulation Certificate for PA WAP guidance	

Topic 4.16 Ducts

Subtopic 4.1601 Insulating Ducts

4.1601.1 Insulating Flex Ducts

Topic: Ducts

Subtopic: Insulating Ducts

Desired Outcome: Lower conductive heat transfer by ducts and decreased condensation on duct [vapor barrier](#)

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

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

Title	Specification(s)	Objective(s)
4.1601.1h Sealing of all accessible ducts	All accessible joints, seams, and connections in ductwork will be securely fastened and sealed with <i>UL</i> "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 <i>vapor retarder</i>	Minimize thermal conductance of the duct system
4.1601.1j Completeness of vapor barrier	<i>Vapor retarder</i> of all duct insulation will be taped to the flex duct using tape that complies with <i>UL</i> 181B and will be marked "181 B-FX" for pressure-sensitive tape or "181 B-M" for mastic	Ensure a complete <i>vapor barrier</i>

4.1601.2 Insulating Metal Ducts

Topic: Ducts

Subtopic: Insulating Ducts

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

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

Title	Specification(s)	Objective(s)
4.1601.2a Selection of duct insulation material	<p>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 <i>vapor retarder</i></p> <p>Hot humid and warm coastal regions will not bury ducts</p>	Decrease heat loss and condensation problems



Before

Uninsulated ducts in unconditioned spaces are an energy drain



After

Properly insulated ducts operate at much higher rates of efficiency



Ducts in unconditioned areas should have r-8 insulation with vapor barrier



OR ducts can be buried in loose fill in attic spaces in drier climates



Burying ducts is discouraged in warm coastal and hot humid regions

Title	Specification(s)	Objective(s)
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



Before

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



After

Sealed ductwork connections help prevent leakage

Tools:

1. Putty knife

Materials:

1. Mesh tape
2. Mastic



Prepare work area by assessing any safety concerns



Wrap joint with fiberglass mesh tape



Apply UL 181 mastic to seal joint

Title	Specification(s)	Objective(s)
4.1601.2c Attachment of duct insulation	<p>Duct insulation will be secured to the duct system using metal wire or rot-proof nylon twine</p> <p>Pattern of the wire or twine will be sufficient to securely hold the duct insulation tight to the duct</p>	Ensure a secure connection between the duct system and the duct insulation



Before

Materials holding insulation in place should not compress or kink duct

Tools:

1. Scissors
2. Metal snips



After

Durable materials can be attached without compressing insulation

Materials:

1. Nylon twine
2. Wire
3. Tie bands

4.1601.2d Taping of the duct insulation	<p>Using a tape approved by the manufacturer, all seams and connection of the duct insulation will be taped</p> <p>No gaps will exist between pieces of duct insulation</p>	Prevent gaps in the <i>vapor barrier</i> of the insulation
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Before

Unsecured and sealed insulation around ducts is useless

Tools:

1. Utility knife



After

All seams should be sealed with UL-181 duct tape to preserve vapor barrier

Materials:

1. UL-181 tape
2. R-8 duct insulation with vapor barrier

Topic 4.99 Insulation—Additional Resources

Subtopic 4.9901 Materials

4.9901.1 General Information on Spray Polyurethane Foam (SPF)

Topic: Insulation—Additional Resources

Subtopic: Materials

Desired Outcome: To provide general Information on spray polyurethane foam

Title	Specification(s)	Objective(s)
4.9901.1a 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 through unheated hoses through a disposable mixing nozzle system, and applied as a froth-like material to substrate. This type of SPF product is typically used for large sealing and small-scale insulation products.	To provide general Information on spray polyurethane foam
4.9901.1b High-Pressure SPF	<p>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.</p> <p>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.</p> <p>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.</p>	To provide general Information on spray polyurethane foam
4.9901.1c Manufacturer Installation Instructions	In addition to the guidelines above, SPF applicators should follow all manufacturer installation instructions for the product being used. These instructions include product-specific documents, such as application instructions, MSDSs, and evaluation reports.	To provide general Information on spray polyurethane foam

Chapter 5: Heating and Cooling

Combustion appliance testing, including Combustion Appliance Zone (CAZ) testing, is required in all homes with combustion appliances.

Follow SWS Section 2.02: Combustion Safety for combustion safety and CAZ testing*: <https://sws.nrel.gov/spec/202>.

***SWS 2.0201.1i: At the conclusion of each work day in which envelope or duct sealing measures have been performed, depressurization and spillage testing will be performed.**

Always follow manufacturer's specifications for combustion analysis.

Heating System Maintenance & Testing

The SWS Tool contains many specifications for heating systems assessment, maintenance, and testing. PA WAP workers are required to apply the SWS's for heating/cooling as stated in this field manual.

Furnace Replacement Documentation:

Documentation, both written and photographic, must completely detail the nature and cause of replacing a furnace.

For example, photographic documentation must indicate the existing furnace's cracked heat exchanger or leaking boiler. Photographic documentation must clearly indicate the existing furnace's faceplate, including the model number and serial number.

Photographic documentation must show the existing furnace in the home prior to being moved.

Photographic documentation must fully document the new furnace in the home.

Documentation must indicate that Manual J procedures have been followed, and that a load calculation was performed to determine the correct sizing of the replacement unit. Results of Manual J calculations must be included.

Adhere to the heating-related topics referenced in the *DCED Directive: Health and Safety*.

Access the most current directive on DCED's extranet website:

<https://collab.pa.gov/dced/weatherization>.

Other Considerations:

Heat pumps that exist as the primary heating system may be repaired or replaced.

Due to corrosion of aluminum liners, when installing a gas appliance into a previous oil or solid fuel chimney, stainless steel liners are strongly recommended.

Crosswalk of Heating & Cooling SWS with the ANSI/BPI 1100 Energy Auditing Standard

The SWS for Health and Safety will apply to Auditors as they follow the ANSI-BPI-1100-T-2014 Home Energy Auditing Standard sections 7 and 11.

5. Heating & Cooling SWS

Topic 5.30 Forced Air

Subtopic 5.3001 Design

5.3001.1 Load Calculation and Equipment Selection

Topic: Forced Air

Subtopic: Design

Desired Outcome: Equipment sized properly and operates efficiently

For supporting material, see [Calculation of the Infiltration Credit](#) and [Referenced Standards](#).

Title	Specification(s)	Objective(s)
5.3001.1a Load calculation	Load calculation will be performed in accordance with ANSI / ACCA 2 Manual J-2011 (Residential Load Calculation) and manufacturer specifications	Properly size equipment for load
PA WAP Guidance:	Apply to all weatherized homes and compare to existing furnace sizing.	
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
PA WAP Guidance:	Apply to all new heating systems installed.	
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
PA WAP Guidance:	Apply to all new heating systems installed.	

5.3001.2 Ductwork and Termination Design

Topic: Forced Air

Subtopic: Design

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

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

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
PA WAP Guidance:	Apply to all new heating systems installed.	
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
PA WAP Guidance:	Apply to all new heating systems installed.	
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
PA WAP Guidance:	Apply to all new heating systems installed.	

Subtopic 5.3002 Site Preparation

5.3002.1 Preparation for New Equipment

Topic: Forced Air

Subtopic: Site Preparation

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.

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
PA WAP Guidance:	Follow DOE lead-safe work practices.	

Subtopic 5.3003 System Assessment and Maintenance

5.3003.1 Data Plate Verification

Topic: Forced Air

Subtopic: System Assessment and Maintenance

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

Title	Specification(s)	Objective(s)
5.3003.1a Data plate verification	Equipment will be visually inspected Information will be recorded from the equipment data plates indoors and outdoors	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

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 material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

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
PA WAP Guidance:	Apply during a Clean & Tune.	



Locate nozzles on oil-fired water heaters and furnaces.
Verify that nozzle size is appropriate for model by consulting manufacturer's specifications.

Title	Specification(s)	Objective(s)
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
PA WAP Guidance:	Apply during a Clean & Tune.	



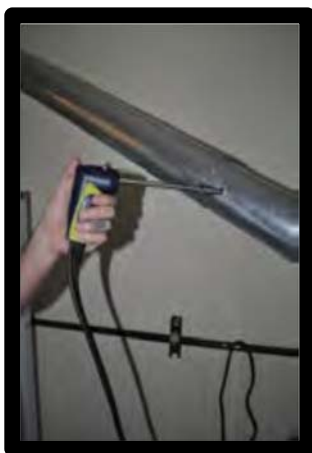
Check oil-fired furnaces and water heaters for proper fuel pressure



After

Verify that fuel pressure matches manufacturer's specifications

Title	Specification(s)	Objective(s)
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
PA WAP Guidance:	Apply during the Energy Audit, Clean & Tune, the Auditor Quality Check (post-weatherization), and at the Quality Control Inspection.	



In Progress

Test flue gases to determine steady state efficiency



After

At steady state, this furnace tests at 83%-- within manufacturer tolerances

Tools:

1. Combustion analyzer with probe

Title	Specification(s)	Objective(s)
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
PA WAP Guidance:	Apply during the Energy Audit, Clean & Tune, the Auditor Quality Check (post-weatherization), and at the Quality Control Inspection.	



Verify oil-fired furnaces and water heaters are operating safely

Tools:

1. Smoke testing pump

Materials:

1. Filter paper



Best Practice

Smoke tests determine if oil-fired appliances burn cleanly by testing for soot



Draw air through paper as per manufacturer's instructions

Title	Specification(s)	Objective(s)
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
PA WAP Guidance:	Apply during the Energy Audit, Clean & Tune, the Auditor Quality Check (post-weatherization), and at the Quality Control Inspection.	



In Progress

Verify oil-fired appliances are not burning hotter than manufacturer specs



After

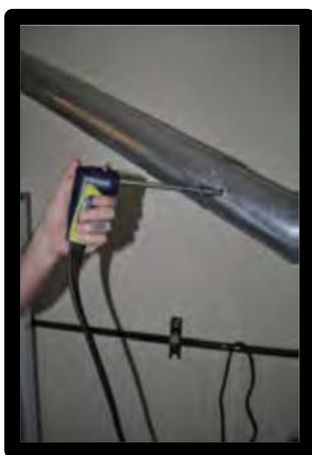
T-stack minus T-air equals net stack temperature. Check against specs

Tools:

1. Combustion analyzer with probe

T=temperature. T-stack minus T-air = Delta T or Net Stack Temperature.

Title	Specification(s)	Objective(s)
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
PA WAP Guidance:	Apply during the Energy Audit, Clean & Tune, the Auditor Quality Check (post-weatherization), and at the Quality Control Inspection.	



In Progress

Verify oil-fired appliances are burning safely by testing CO₂ and O₂ levels



After

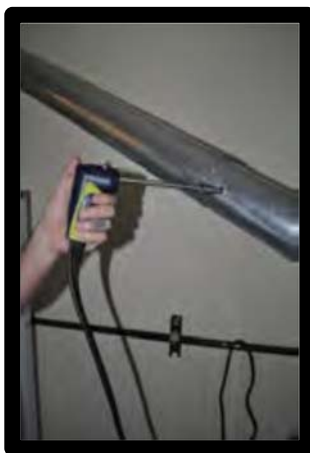
Levels should be within industry standards and match manufacturer specs

Tools:

1. Combustion analyzer with probe
2. Drill

O₂ levels in the atmosphere are at a constant 20.9%. O₂ readings in appliances vary due to O₂ density and the efficiency of the combustion process.

Title	Specification(s)	Objective(s)
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
PA WAP Guidance:	Apply during the Energy Audit, Clean & Tune, the Auditor Quality Check (post-weatherization), and at the Quality Control Inspection.	



In Progress

Oil-fired appliances require an appropriate level of air mixed with the oil



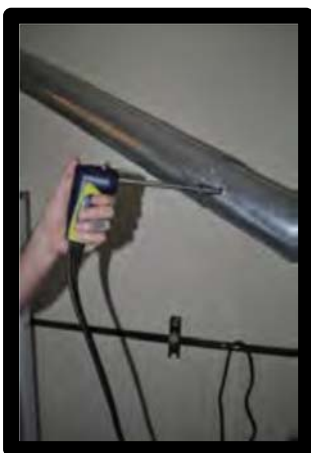
After

The percentage of Excess Air (EA) should be within manufacturer specs

Tools:

1. Combustion analyzer with probe
2. Drill

Title	Specification(s)	Objective(s)
5.3003.2h CO in flue gas	<p>Undiluted flue gases will be checked with a calibrated combustion analyzer</p> <p>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)</p>	<p>Ensure equipment operates as designed</p> <p>Ensure equipment operates safely</p> <p>Ensure equipment operates efficiently</p> <p>Ensure equipment is durable</p>
PA WAP Guidance:	Apply during the Energy Audit, Clean & Tune, the Auditor Quality Check (post-weatherization), and at the Quality Control Inspection.	

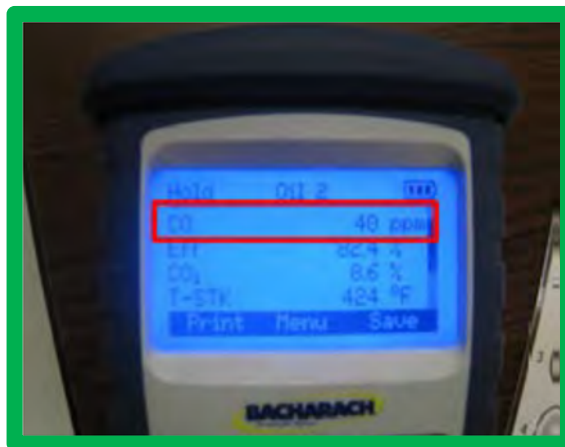


In Progress

Test oil-fired appliances for CO in the flue gases to verify safe levels

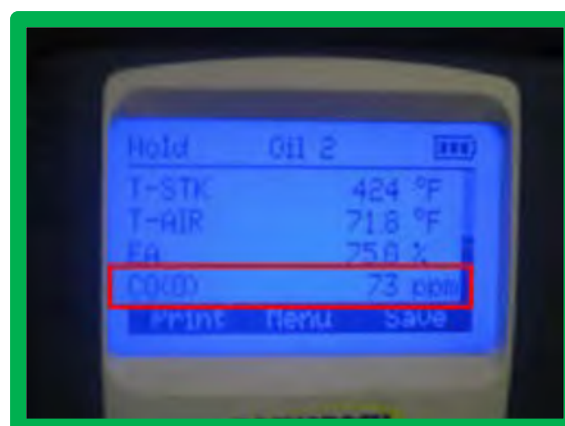
Tools:

1. Combustion analyzer with probe
2. Drill



After

CO should measure less than 200 ppm



After

Air-free CO, or CO(0), should be less than 400 ppm

5.3003.3 Evaluating Air Flow

Topic: Forced Air

Subtopic: System Assessment and Maintenance

Desired Outcome: Air flow is properly tested

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

Title	Specification(s)	Objective(s)
5.3003.3a Total air flow	<p>Total system air flow will be measured by:</p> <ul style="list-style-type: none"> • Temperature rise • Flow plate • Fan depressurization device (e.g., Duct Blaster, DucTester) 	<p>Ensure equipment operates as designed</p> <p>Ensure equipment operates efficiently</p> <p>Ensure equipment provides comfort</p> <p>Ensure equipment operates safely</p> <p>Ensure equipment is durable</p>
PA WAP Guidance:	Apply during Clean & Tune and new furnace installation.	
5.3003.3b External static pressure	<p>External static pressure will be in accordance with manufacturer specifications</p>	<p>Ensure equipment operates as designed</p> <p>Ensure equipment operates efficiently</p> <p>Ensure equipment provides comfort</p> <p>Ensure equipment operates safely</p> <p>Ensure equipment is durable</p>
PA WAP Guidance:	Apply during Clean & Tune and new furnace installation.	
5.3003.3c Pressure	<p>Pressure drop across cooling coils will be in accordance with manufacturer specifications</p>	<p>Ensure equipment operates as designed</p> <p>Ensure equipment operates efficiently</p> <p>Ensure equipment provides comfort</p> <p>Ensure equipment operates safely</p> <p>Ensure equipment is durable</p>
PA WAP Guidance:	Apply during Clean & Tune and new furnace installation if an air conditioning coil exists.	

Title	Specification(s)	Objective(s)
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
PA WAP Guidance:	Apply during Clean & Tune and new furnace installation.	
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
PA WAP Guidance:	Apply when installation includes a new complete ducted system.	
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
PA WAP Guidance:	Apply only on heat pumps. Air conditioning is not an allowable measure in PA WAP, except if it is a heat pump system (either add-on or stand-alone).	
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
PA WAP Guidance:	Apply only on heat pumps. Air conditioning is not an allowable measure in PA WAP, except if it is a heat pump system (either add-on or stand-alone).	

Title	Specification(s)	Objective(s)
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
PA WAP Guidance:	Apply during the Energy Audit, Clean & Tune, the Auditor Quality Check (post-weatherization), and at the Quality Control Inspection.	

5.3003.4 Evaluating Electrical Service

Topic: Forced Air

Subtopic: System Assessment and Maintenance

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 material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

Title	Specification(s)	Objective(s)
5.3003.4a Polarity	Polarity of equipment will be correct	Ensure equipment operates as designed Ensure equipment operates safely
PA WAP Guidance:	Apply during Clean & Tune.	
5.3003.4b Voltage/amperage: incoming power	Voltage/amperage will be in accordance with manufacturer specifications	Ensure equipment operates as designed
PA WAP Guidance:	Apply during Clean & Tune.	
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
PA WAP Guidance:	Apply during Clean & Tune.	

Title	Specification(s)	Objective(s)
5.3003.4d Grounding	Grounding must conform to meet <i>NFPA</i> 70 National Electric Code	Ensure equipment operates as designed Ensure equipment operates safely
PA WAP Guidance:	Apply during the Energy Audit, Clean & Tune, the Auditor Quality Check (post-weatherization), and at the Quality Control Inspection. Visual inspection. Apply to all systems.	
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
PA WAP Guidance:	Apply only on heat pumps during Clean & Tune and on new installations.	
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
PA WAP Guidance:	Apply only on heat pumps during Clean & Tune and on new installations.	
5.3003.4g Door switch operation	Blower compartment safety switch operation will be verified	Ensure blower does not operate during service
PA WAP Guidance:	Apply during the Energy Audit, Clean & Tune, the Auditor Quality Check (post-weatherization), and at the Quality Control Inspection. Visual inspection. Apply to all systems.	
5.3003.4h Heat pump: emergency heat	Emergency heat circuit functions will be verified	Ensure system delivers heat in case of compressor failure
PA WAP Guidance:	Apply during Clean & Tune on heat pumps.	

5.3003.5 Refrigerant Line Inspection

Topic: Forced Air

Subtopic: System Assessment and Maintenance

Desired Outcome: Refrigerant lines properly installed

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

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

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
PA WAP Guidance:	Apply only on heat pumps.	
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
PA WAP Guidance:	Apply only on heat pumps.	
5.3003.5c Sizing	Refrigerant lines will be sized to meet manufacturer specifications for the installed equipment	Ensure system moves appropriate volume of refrigerant
PA WAP Guidance:	Apply only on heat pumps.	
5.3003.5d Installation quality	Refrigerant lines will be installed without kinks, crimps, or excessive bends	Ensure system moves appropriate volume of refrigerant
PA WAP Guidance:	Apply only on heat pumps.	
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
PA WAP Guidance:	Apply only on heat pumps.	

5.3003.6 Evaluating Sequence of Operation

Topic: Forced Air

Subtopic: System Assessment and Maintenance

Desired Outcome: Sequence of operation of the system verified

Title	Specification(s)	Objective(s)
5.3003.6a Verification	The sequence of operation of the system will be verified in accordance with the manufacturer installation, operation, and maintenance manual	Ensure system components function and operate in the correct sequence

5.3003.7 Occupant Education

Topic: Forced Air

Subtopic: System Assessment and Maintenance

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

For supporting material, see [Calculation of the Infiltration Credit](#) and [Referenced Standards](#).

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
PA WAP Guidance:	Installation or service on humidifiers on heating systems is not allowable in PA. Recommend removing existing humidifiers if there are existing or potential moisture issues.	
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

Title	Specification(s)	Objective(s)
5.3003.7e Blocking air flow	<p>Importance of cleaning dust and debris from return grilles will be explained to occupant</p> <p>Proper placement of interior furnishings with respect to registers will be explained to occupant</p> <p>Negative consequences of closing registers will be explained to occupant</p> <p>Importance of leaving interior doors open as much as possible will be explained to occupant</p>	<p>Ensure occupant does not prevent equipment from operating as designed</p>
5.3003.7f Routine maintenance	<p>Proper filter selection and how to change the filter will be explained to occupant</p> <p>Importance of keeping outside unit clear of debris, vegetation, decks, and other blockage will be explained to occupant</p> <p>Importance and timing of routine professional maintenance will be explained to occupant</p> <p>There will be no air bypass around the filters and new central forced air <i>HVAC</i> systems will have minimum <i>MERV</i> 6 filtration</p>	<p>Ensure equipment operates as designed</p>
5.3003.7g Calling heating, ventilation, and air conditioning (HVAC) contractor	<p>Situations when the occupant should contact the <i>HVAC</i> contractor will be explained, including:</p> <ul style="list-style-type: none"> • 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 	<p>Notify occupant to contact installer when system is not operating as designed</p>
5.3003.7h Carbon monoxide (CO)	<p>A carbon monoxide (<i>CO</i>) alarm will be installed</p>	<p>Occupant will be made aware of operation of <i>CO</i> alarm</p>
5.3003.7i Warranty and service	<p>Occupant will be provided with relevant manuals and warranties</p> <p>The labor warranty will be explained and the occupant will be given a phone number to call for warranty service</p>	<p>Provide manuals and warranties for future servicing</p>

5.3003.8 Evaporative Cooler Maintenance and Repairs

Topic: Forced Air

Subtopic: System Assessment and Maintenance

Desired Outcome: Evaporative cooler evaluated and maintained as needed

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

PA WAP Guidance: 5.3003.8 Evaporative Cooler Maintenance and Repairs	Evaporative Coolers are not an allowable measure in PA. Do not apply the SWS's in Detail 5.3003.8.
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5.3003.9 Heating and Cooling Controls

Topic: Forced Air

Subtopic: System Assessment and Maintenance

Desired Outcome: Heating and cooling controls installed and set properly

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

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
PA WAP Guidance:	Confirm that there is an override to this control that will allow the emergency heat to operate under outdoor equipment failure.	

Title	Specification(s)	Objective(s)
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
PA WAP Guidance:	Humidistat installation is not an allowable measure in the PA WAP. Do not apply this SWS.	
5.3003.9n Occupant education	Occupants will be educated on proper use of thermostat including: <ul style="list-style-type: none"> • 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

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 material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

Title	Specification(s)	Objective(s)
5.3003.10a Connection	Connections in condensate drain system will be watertight	Ensure condensate drain connections do not leak



Before

HVAC equipment needs condensate drainage to prevent water damage

Tools:

1. Hacksaw
2. Crimper



In Progress

Drainage pipes should be sealed to be watertight

Materials:

1. Pex piping and angles
2. PVC piping and angles
3. Purple primer

Title	Specification(s)	Objective(s)
5.3003.10b Insulation	Condensate drainlines will be insulated with a minimum 1" of insulation with a <i>vapor retarder</i> when there is potential for condensation or freezing on the drainline	Ensure condensate drain connections do not leak



Before

Once drainage pipes cross into unconditioned space, they can freeze

Tools:

1. Tape measure
2. Utility knife



After

Pipes in unconditioned spaces should be insulated with 1" pipe insulation

Materials:

1. 1" thick pipe insulation
2. Zip ties

5.3003.10c Overflow protection: upflow	<p>Secondary drain pan and float switch will be installed when overflow could damage finished surfaces</p> <p>OR</p> <p>Float switch in the primary condensate drain for upflow systems will be installed when overflow could damage finished surfaces</p>	Ensure condensate drain connections do not leak
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A float switch should be installed to prevent overflow and damage

Title	Specification(s)	Objective(s)
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



Before

HVAC equipment that drains upward through a roof cannot drain naturally



After

For non-gravity draining systems, a pump is necessary



HVAC unit is mounted to "historic" adobe wall which cannot be penetrated



For non-gravity draining systems, a pump is necessary



For non-gravity draining systems, a pump is necessary

Title	Specification(s)	Objective(s)
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



Float switches should be installed in drainage pans to prevent overflow

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

Topic: Forced Air

Subtopic: System Assessment and Maintenance

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

Title	Specification(s)	Objective(s)
5.3003.14a Place appliance in operation	Heating equipment will be placed in operation in accordance with applicable NFPA standards and manufacturer specifications when available	Ensure equipment: <ul style="list-style-type: none"> • Operates as designed • Operates safely • Operates efficiently • Is durable
5.3003.14b Gas pressure	Measurement will be verified by a certified professional in accordance with fuel type and manufacturer specifications	Ensure equipment: <ul style="list-style-type: none"> • Operates as designed • Operates safely • Operates efficiently • Is durable
5.3003.14c Carbon dioxide (CO2) and oxygen (O2)	Measurement will be verified in accordance with industry manuals (e.g., Testo, Bacharach)	Ensure equipment: <ul style="list-style-type: none"> • Operates as designed • Operates safely • Operates efficiently • Is durable
5.3003.14d Excess combustion air	Excess combustion air will be calculated and verified in accordance with industry manuals (e.g., Testo, Bacharach)	Ensure equipment: <ul style="list-style-type: none"> • Operates as designed • Operates safely • Operates efficiently • Is durable
5.3003.14e Carbon monoxide (CO) in flue gas	CO in the undiluted flue gas will be less than 100 ppm	Ensure equipment: <ul style="list-style-type: none"> • Operates as designed • Operates safely • Operates efficiently • Is durable
5.3003.14f Testing/inspection holes	All testing and inspection holes will be sealed with manufacturer approved materials	Ensure equipment: <ul style="list-style-type: none"> • Operates as designed • Operates safely • Operates efficiently • Is durable

Topic 5.31 Hydronic Heating (Hot Water and Steam)

Subtopic 5.3101 Design

5.3101.1 Heat Load Calculation—Whole House

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Design

Desired Outcome: A properly sized heating appliance selected

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

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
PA WAP Guidance:	Always apply when installing any energy conservation measures that would reduce the heating BTU load of the structure and when replacing an existing boiler.	
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 (Hot Water and Steam)

Subtopic: Design

Desired Outcome: Heat emitter selected provides adequate heat output

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

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
PA WAP Guidance:	Apply always when adding or installing new emitters (baseboard or radiators).	

Subtopic 5.3104 Equipment Maintenance, Testing, and Repair

5.3104.1 Controls—Thermostat Replacement

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Maintenance, Testing, and Repair

Desired Outcome: Thermostat replaced when appropriate

Title	Specification(s)	Objective(s)
5.3104.1a Visual inspection	<p>Thermostats will be visually located</p> <p>Verify anticipator setting, if appropriate for thermostat model</p> <p>Replacement will be recommended if a digital, double setback thermostat is not present</p>	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)	<p>Heating system will be de-energized before removal</p> <p>Thermostat will be removed</p> <p>Compatibility will be verified (e.g., voltage, wiring condition, location) and documented</p> <p>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)</p>	Proper removal of thermostat
5.3104.1d Installation	<p>Location for new thermostat will be determined</p> <p>Compatibility with new thermostat will be verified (e.g., voltage, wiring, condition, location)</p> <p>Replacement will be recommended if a digital, double setback thermostat is not present</p> <p>Heating system will be re-energized and cycled</p> <p>Thermostat will be programmed to occupant lifestyle choices</p>	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	<p>Occupant will be involved in the initial programming of thermostat and educated on common settings and programming</p> <p>On new installs, occupants will be encouraged to save the manual and keep it accessible</p>	Educate occupant on best use

5.3104.2 Maintenance: Gas Boiler Service Inspection

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Maintenance, Testing, and Repair

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

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

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

Title	Specification(s)	Objective(s)
5.3104.2a Visual inspection	<p>The following conditions will be assessed by a licensed contractor:</p> <ul style="list-style-type: none">• 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
PA WAP Guidance:	PA does not have a statewide licensed contractor requirement. The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail. Otherwise, a qualified technician is required.	
5.3104.2b Appliance gas valve	When replacement is necessary, gas valve will be removed and replaced according to manufacturer specifications	<p>Provide gas to burner when there is a call for heat</p> <p>Control volume of gas for burner</p> <p>Ensure the safe shut off of gas at the end of a call for heat</p>
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

Title	Specification(s)	Objective(s)
5.3104.2f Flue gas testing	<p>Undiluted flue gases will be checked with a calibrated combustion analyzer in accordance with <i>BPI</i> -1100-T-2012</p> <p>If combustion is not in compliance with <i>BPI</i> -1100-T-2012, diagnostics and adjustments will be done to meet manufacturer specifications or local codes</p>	<p>Confirm that combustion occurs safely with maximum efficiency</p>
5.3104.2g Combustion efficiency checks	<p>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</p> <p>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</p>	<p>Increase the operational efficiency of the system</p> <p>Improve occupant comfort</p>
5.3104.2h Occupant health	<p>All homes will have a carbon monoxide (<i>CO</i>) alarm</p>	<p>Ensure ambient <i>CO</i> does not exceed acceptable levels after completion of work</p>
5.3104.2i Occupant education	<p>Occupants will be educated on the operation and maintenance of the carbon monoxide (<i>CO</i>) alarm</p> <p>Completed work and recommended maintenance will be reviewed</p>	<p>Ensure occupant is informed of the safe and efficient operation and maintenance of the work performed</p>

5.3104.3 Maintenance: Checklist

Topic: Hydronic Heating (Hot Water and Steam)

Subtopic: Equipment Maintenance, Testing, and Repair

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 material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

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: <ul style="list-style-type: none">• 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: <ul style="list-style-type: none">• 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: <ul style="list-style-type: none">• 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

Title	Specification(s)	Objective(s)
5.3104.3d Check system pressure	<p>Check system pressure will be verified</p> <p>Check system pressure will be 1 pound per square inch gauge (<i>psig</i>) per 28" of system height</p>	Keep system operating within pressure parameters
PA WAP Guidance:	Apply during a Clean & Tune.	
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
PA WAP Guidance:	Apply during a Clean & Tune.	
5.3104.3f Automatic fill	<p>Automatic fill valve will be inspected to ensure it maintains system pressure</p> <p>If pressure is not maintained, replacement will be made in accordance with the following criteria:</p> <ul style="list-style-type: none"> • 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
PA WAP Guidance:	Apply during a Clean & Tune.	
5.3104.3g Gauge glass	<p>Gauge glass will be inspected for erosion, cracks, or drying</p> <p>Damaged gauge glass on boiler will be replaced in accordance with manufacturer specifications</p> <p>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</p>	Ensure gauge glass is in safe operating condition to allow observation of water level in boiler
PA WAP Guidance:	Visual inspection by Auditor. Replacement by HVAC contractor.	

Title	Specification(s)	Objective(s)
5.3104.3h Low water cut-off: float type	<p>Operation of low-water cutoff on steam boilers will be observed by opening blow-off valve</p> <p>If combustion is not extinguished, remediation will be accomplished by the following procedure:</p> <ul style="list-style-type: none"> • 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 <p>Operation of low-water cutoff on hot water boilers is applicable only if proper test setup is available on-site, to avoid draining the system</p> <p>Occupants will be educated on the correct method to drain the low water cutoff weekly (must drain once per week to remove sediment from float chamber of low-water cutoff)</p>	<p>Ensure safe minimum water level of the boiler</p> <p>Maintain safe operation of the low water cut-off on ongoing basis</p>
5.3104.3i Low water cut-off: immersion	<p>An immersion low-water cutoff will be installed and operable</p>	<p>Ensure safe minimum water level of the boiler</p>
PA WAP Guidance:	Installation by the HVAC contractor during Clean & Tune.	
5.3104.3j Expansion tank: non-bladder and bladder	<p>An expansion tank will be installed and operable</p> <p>Tanks that leak or have excessive corrosion will be replaced, and non- bladder tanks will include an expansion tank drain</p> <p>Tank will be installed in accordance with manufacturer specifications</p> <p>Expansion tanks will be properly supported with strapping</p> <p>Tanks that are full of water will be drained; after expansion tank is drained, re-establish the correct water level in relation to system pressure</p> <p>Expansion tanks with bladders will have air charged to the manufacturer pressure specifications while water is not present in the tank</p> <p>Bladder tanks that have water inside of the air bladder will be replaced in accordance with manufacturer specifications</p>	<p>Absorb water expansion of the system</p>
PA WAP Guidance:	Include as part of the Clean & Tune inspection for boilers.	

Title	Specification(s)	Objective(s)
5.3104.3k Flush or skim steam boiler	Manufacturer specifications for flushing or skimming steam boiler will be followed	Ensure boiler produces dry steam
5.3104.3l System temperature or pressure gauge	<p>The temperature or pressure gauge will be inspected for erosion, cracks, or dirt</p> <p>Damaged temperature or pressure gauges will be replaced in accordance with manufacturer specifications</p>	Allow for accurate observation of system temperature and pressure
PA WAP Guidance:	Visual inspection by Auditor. Replacement by HVAC contractor.	
5.3104.3m Circulators	<p>Non-working motors that cannot be serviced will be replaced with a new motor</p> <p>New motors will be installed in accordance with manufacturer specifications</p> <p>Oil-lubricated circulators will be installed in proper alignment with the pump coupler and will be supported so they do not sag</p> <p>Bearings will have free movement without binding</p> <p>Shaft seals will not leak</p> <p>Bearings in inoperable, water-lubricated circulators will be freed, if possible, before replacement with a new circulation pump</p>	Ensure circulation of water at designated velocity in system without leaks in the circulators
PA WAP Guidance:	Visual inspection by Auditor. Replacement by HVAC contractor.	
5.3104.3n Zone valves	<p>Zone valves will be inspected for the following conditions:</p> <ul style="list-style-type: none"> • Leaking water • Not responding to a call for heat <p>New equipment will be replaced in accordance with manufacturer specifications</p>	Ensure proper zonal control of the system for comfort and efficiency
PA WAP Guidance:	Visual inspection by Auditor. Replacement by HVAC contractor.	

Title	Specification(s)	Objective(s)
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

Topic 5.32 Shading

Subtopic 5.3201 Landscaping

5.3201.1 Indigenous Shading

Topic: Shading

Subtopic: Landscaping

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

PA WAP Guidance: 5.3201.1 Indigenous Shading	Indigenous shading is not an allowable measure in PA. Do not apply the SWS's in Detail 5.3201.1.
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Chapter 6: Ventilation

Agencies must calculate the minimum ventilation needed. Minimum ventilation determination must follow the ASHRAE 62.2-2013 Standard.

Adhere to the ventilation-related topics referenced in the *DCED Directive: Health and Safety*.

Crosswalk of Ventilation SWS with the ANSI/BPI 1100 Energy Auditing Standard

The SWS for Health and Safety will apply to Auditors as they follow the ANSI-BPI-1100-T-2014 Home Energy Auditing Standard sections 3, 8, 9 and 12.

6. Ventilation SWS

Topic 6.60 Exhaust

Subtopic 6.6002 Components

6.6002.1 Ducts

Topic: Exhaust

Subtopic: Components

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

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

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



Before

Duct work for exhaust fans should be short, smooth, and not pinch down

Tools:

1. Metal snips
2. Drill

See also ASHRAE 62.2-2013.



After

Duct is the same size as the outlet and makes shortest run possible

Materials:

1. Metal duct piping
2. Fasteners

Title	Specification(s)	Objective(s)
6.6002.1b Duct insulation	Ducts installed outside of the thermal <i>envelope</i> will be insulated to a minimum of R-8 or equivalent to local codes	Prevent condensation from forming or collecting inside of the ductwork



Before

Uninsulated ducts in unconditioned spaces are an energy drain

Tools:

1. Utility knife
2. Metal snips

See also ASHRAE 62.2-2013.
Check local codes to see if R-8 is accepted level of insulation.



After

Properly insulated ducts operate at much higher rates of efficiency

Materials:

1. R-8 insulation with vapor barrier
2. Nylon twine
3. Wire
4. UL-181 duct tape

Title	Specification(s)	Objective(s)
6.6002.1c Duct support	<p>Flexible and duct board ducts and plenums will be supported every 4' using a minimum of 1 1/2" wide material</p> <p>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</p> <p>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</p>	<p>Effectively move the required volume of air</p> <p>Preserve the integrity of the duct system</p> <p>Eliminate falling and sagging</p>



Before

Ducts should not be allowed to droop and sag to maximize efficiency

Tools:

1. Drill
2. Metal snips
3. Utility knife

See also ASHRAE 62.2-2013.



After

Supports should be evenly spaced to allow for minimal distance of run

Materials:

1. Durable straps at least 1 1/2" wide
2. 18 gauge metal strap at least 1/2" wide
3. 12 gauge galvanized wire
4. Staples
5. Fasteners

Title	Specification(s)	Objective(s)
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6.6002.1c Duct support



BAD: Make sure supports DO NOT compress insulation or duct



Flex ducts should have supports at least every 4 feet



Durable strap should be at least 1 ½ inches wide



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



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



Metal wire should be at least 12 gauge and galvanized

Title	Specification(s)	Objective(s)
6.6002.1d Duct connections	<p>Round metal-to-metal or metal-to-PVC will be fastened with a minimum of three equally spaced screws</p> <p>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</p> <p>Flexible duct-to-metal or flexible duct-to-PVC will be fastened with tie bands using a <i>tie band</i> tensioning tool</p> <p>PVC-to-PVC materials will be fastened with approved PVC cement</p> <p>Other specialized duct fittings will be fastened in accordance with manufacturer specifications</p> <p>In addition to mechanical fasteners, duct connections will be sealed with <i>UL</i> 181B or 181B-M listed material</p>	<p>Effectively move the required volume of air</p> <p>Preserve the integrity of the duct system</p>



Before

Fan duct is disconnected and venting into the attic space

Tools:

1. drill
2. tie band tensioner
3. brush



After

Fan has been vented with sealed, insulated duct material

Materials:

1. tie bands
2. insulated flex duct
3. mastic
4. PVC primer
5. PVC cement

Title	Specification(s)	Objective(s)
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6.6002.1d Duct connections



Apply mastic to the connection fitting



Snug duct liner onto connection fitting



Use zip tie and tensioner to secure liner to connection fitting



Apply mastic to fan connection



Using mechanical fasteners, secure connection fitting to fan connection



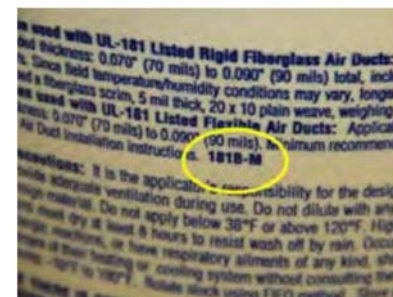
Snug insulation to fan housing and strap into place



Round metal-to-metal connections require fiberglass mesh tape and 3 mechanical fasteners minimum



PVC-to-PVC connections should use PVC primer and cement



Sealants should show UL181-M or UL181B-M

Title	Specification(s)	Objective(s)
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



Bad Practice

Existing duct is installed incorrectly and is not UL listed



Best Practice

This flexible duct conforms to UL 181

Materials:

1. All materials should be UL 181 Listed
2. 30-gauge minimum Rigid Duct



Look for the Air Diffusion Council seal



Flex installed should meet or exceed UL 181



When rigid duct is being used, its wall thickness should be 30 gauge minimum

6.6002.2 Terminations

Topic: Exhaust

Subtopic: Components

Desired Outcome: Securely installed termination fittings with unrestricted air flow

For supporting material, see [Calculation of the Infiltration Credit](#) and [Referenced Standards](#).

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



Before

Exhaust fans need exterior ventilation, often through roofs and walls



After

Hole should be no more than 1/4" larger than termination fitting diameter

Tools:

1. Hole saw
2. Drill
3. Tape measure



Locate the center of your vent hole by drilling from inside through roof



Measure the termination fitting to determine proper hole saw diameter



Based on termination fitting size (in this case, 4"), mark to cut hole



Hole should be no more than 1/4" larger than termination fitting diameter



Verify hole size is correct before installation

Title	Specification(s)	Objective(s)
6.6002.2b Termination fitting	<p>A termination fitting with an integrated collar will be used</p> <p>Collar will be at least the same diameter as the exhaust fan outlet; if collar is larger than exhaust fan outlet, a rigid metal transition will be used</p> <p>Fitting will be appropriate for regional weather conditions and installation location on house so as not to be rendered inoperable</p>	<p>Effectively move the required volume of air to the outside</p> <p>Preserve integrity of the building <i>envelope</i></p> <p>Ensure durable installation</p>



Before

Termination fittings with no collar are to be avoided

Tools:

1. Drill

Materials:

1. Fasteners



After

Properly sized ducts with snug connections to collared fittings last longer



BAD: Termination fittings without collars should be avoided



Termination fittings with collars should be used for exhaust ventilation



Collared fittings extend through the roof to fasten securely with duct

Title	Specification(s)	Objective(s)
6.6002.2c Duct to termination connection	<p>Duct will be connected and sealed to termination fitting as follows:</p> <ul style="list-style-type: none"> • <i>Round metal-to-metal or metal-to-PVC will be fastened with a minimum of three equally spaced screws</i> • 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 <i>tie band</i> 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 <i>UL 181B</i> or 181B-M listed material <p>Fasteners will not inhibit damper operation</p>	<p>Effectively move the required volume of air to the outside</p> <p>Preserve integrity of the building <i>envelope</i></p> <p>Ensure durable installation</p>
PA WAP Guidance:	SWS VARIANCE REQUESTED: Do not apply first bullet to dryer vents. Screws may catch lint and cause a fire hazard.	



Before

Termination is not mechanically fastened, or sealed appropriately

Tools:

1. wire cutter
2. chip brush
3. zip tie tension tool
4. utility knife



After

Termination fitting is secure, and duct is sealed to termination

Materials:

1. insulated flex duct with liner
2. UL 181 sealant
3. zip tie straps
4. PVC primer
5. PVC cement

Title	Specification(s)	Objective(s)
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6.6002.2c Duct to termination connection



With the other end of the duct connected to the fan, cut duct to desired length



Apply mastic to termination fitting



Fit duct liner on to termination fitting



With duct liner in place, use the zip tie tension tool to secure the liner to the fitting



With liner secured and zip tie trimmed, you are ready to pull the insulation to cover the fitting



Round metal-to-metal connections require fiberglass mesh tape and 3 mechanical fasteners minimum



PVC-to-PVC connections should use PVC primer and cement



Sealants should show UL181-M or UL181B-M

Title	Specification(s)	Objective(s)
6.6002.2d Weatherproof installation	<p>Exterior termination fitting will be flashed or weather sealed</p> <p>Water will be directed away from penetration</p> <p>Installation will not inhibit damper operation</p> <p>Manufacturer specifications will be followed</p>	<p>Preserve integrity of the building <i>envelope</i></p> <p>Ensure a weather tight and durable termination installation</p> <p>Ensure unrestricted air flow</p>



Before

Holes for termination fitting need to be sealed to weatherproof



After

Termination installation should follow shingling to deter water penetration



Tools:

1. Hole saw
2. Caulk gun
3. Drill

Materials:

1. Fasteners
2. Caulk

Termination fitting is installed to repel water and sealed

6.6002.2e Pest exclusion	<p><i>Screen material with no less than ¼" and no greater than ½" hole size in any direction will be used</i></p> <p>Installation will not inhibit damper operation or restrict air flow</p>	<p>Prevent pest entry</p> <p>Ensure proper air flow</p>
PA WAP Guidance:	SWS VARIANCE REQUESTED: Do not install screens on dryer vents per IRC.	

Title	Specification(s)	Objective(s)
6.6002.2f Termination location	<p>Terminations will be ducted to the outdoors, which does not include unconditioned spaces such as attics and crawl spaces that are ventilated with the outdoors.</p> <p>Terminations will be installed:</p> <ul style="list-style-type: none"> • 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



Before

Exhaust vent has been improperly mounted too close to mechanical vent



After

Exhaust vent was properly mounted over 3ft from door, window, and deed line

Tools:

1. Measuring tape
2. Hole saw
3. Drill

6.6002.2g Kitchen exhaust	Galvanized steel, stainless steel, or copper will be used for termination fitting for kitchen exhaust	Prevent a fire hazard
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Before

Kitchen exhaust vents should not be made from highly combustible materials



After

This roof-mounted kitchen exhaust fan is galvanized steel--heat resistant

Tools:

1. Measuring tape
2. Hole saw
3. Drill

6.6002.3 Exhaust-Only Ventilation—Fan Intake Grille Location

Topic: Exhaust

Subtopic: Components

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

Title	Specification(s)	Objective(s)
6.6002.3a Primary whole house ventilation	Fan intake grille will be installed in a central location within the main body of the house Ensure it is accessible for filter change and cleaning	Provide whole house air exchange
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

Subtopic 6.6003 Fans

6.6003.1 Surface-Mounted Ducted

Topic: Exhaust

Subtopic: Fans

Desired Outcome: Surface-mounted ducted fans installed to specification

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

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

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

Title	Specification(s)	Objective(s)
6.6003.1c Fan mounting	<p>Fan outlet will be oriented toward the final termination location</p> <p>Fan will be oriented so the equivalent length of the duct run is as short as possible</p> <p>Fan will be mounted securely in accordance with manufacturer specifications</p>	<p>Ensure short duct run to achieve optimum air flow</p> <p>Ensure a secure installation</p> <p>Ensure fan housing does not shake, rattle, or hum when operating</p>
6.6003.1d Backdraft damper	A <i>backdraft damper</i> 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	<p>Duct-to-fan outlet will be connected and sealed as follows:</p> <ul style="list-style-type: none"> • 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 <i>tie band</i> 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 <i>UL</i> 181B or 181B-M listed material 	Exhaust to outside
6.6003.1f Fan housing seal	<p>Gaps and holes in fan housing will be sealed with caulk or other sealants in accordance with manufacturer recommendations</p> <p>Sealants will be compatible with their intended surfaces</p> <p>Sealants will be continuous and meet fire barrier specifications</p>	<p>Prevent air leakage through fan housing</p> <p>Ensure a permanent seal</p> <p>Prevent a fire hazard</p>

Title	Specification(s)	Objective(s)
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 (<i>CFM</i>) 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

Desired Outcome: Inline fans installed to specification

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

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

Title	Specification(s)	Objective(s)
6.6003.2a Wiring	Wiring will be installed 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 <i>service switch</i> will be accessible for maintenance according to <i>NFPA</i> 70 National Electric Code or local authority having jurisdiction	Fan and <i>service switch</i> will be accessible for maintenance

Title	Specification(s)	Objective(s)
6.6003.2c Fan mounting	<p>Fan outlet will be oriented toward the final termination location</p> <p>Fan will be oriented so the equivalent length of the duct run is as short as possible</p> <p>Fan will be mounted securely in accordance with manufacturer specifications</p> <p>Fan will be isolated from the building framing unless specifically designed to be directly attached</p> <p>Fan will be installed remotely by installing ducting from intake grille</p>	<p>Ensure short duct run to achieve optimum air flow</p> <p>Ensure fan is installed securely</p> <p>Ensure fan housing or building framing does not shake, rattle, or hum when operating</p> <p>Minimize noise</p>
6.6003.2d Backdraft damper	A <i>backdraft damper</i> 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	<p>Ducts will be connected and sealed to the intake fan and termination fitting as follows:</p> <ul style="list-style-type: none"> • 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 <i>tie band</i> 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 <i>UL</i> 181B or 181B-M listed material 	<p>Exhaust from desired location to outside</p> <p>Preserve integrity of the duct system and building <i>envelope</i></p>
6.6003.2f Boot to interior surface seal	<p>Sealants will be compatible with their intended surfaces</p> <p>Sealants will be continuous and meet fire barrier specifications</p>	<p>Prevent air leakage around intake housing</p> <p>Prevent a fire hazard</p>
6.6003.2g Air flow	Air flows in <i>CFM</i> will be measured and adjusted to meet the design requirements	Exhaust sufficient air from desired locations to outside

Title	Specification(s)	Objective(s)
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

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 material, see [Calculation of the Infiltration Credit](#) and [Referenced Standards](#).

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



Before

Measure the vent size to compare to opening. 1/4" gap or less is desired



After

Hole size allows sufficient room for vent installation and proper sealing

Title	Specification(s)	Objective(s)
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6.6003.3a Hole in building shell

Tools:

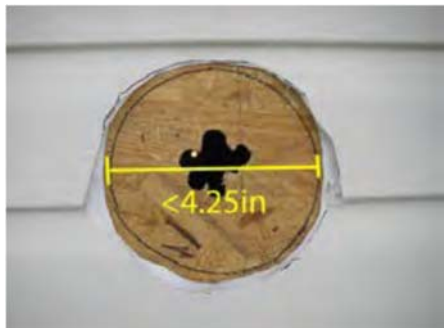
1. Measuring tape
2. Hole saw
3. Drill



Measure the termination fitting to determine proper hole diameter (in this case, 4")



Hole should be no more than 1/4" larger than assembly diameter



Clear wall surface and mark hole size 1/4" larger than termination fitting



Since opening is larger than most hole saws, precision cutting is important

Title	Specification(s)	Objective(s)
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



Before

Incorrect: disconnected ground, no wire nuts on splices, no clamp on wires passing through junction box

Tools:

1. Wire strippers
2. Utility knife or cable ripper
3. Screwdriver
4. Non-contact voltage tester
5. Lineman's pliers



After

Fan junction box with cover installed

Materials:

1. Ground wire crimp sleeves
2. Non-metallic sheathed wire (Type NMB)
e.g., Romex ®
3. Plastic junction box and cover plate
4. Wire nuts
5. Cable staples

Follow manufacturer's specifications and applicable codes when wiring newly installed equipment

Title	Specification(s)	Objective(s)
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6.6003.3b Wiring



Inspect for: proper ground, wire nuts on splices, clamps on wiring where it enters junction box, cover installed on box



Install clamp on wiring into junction box



Install wire nuts on splices



Use crimp sleeves to connect ground wires



Tuck wiring into place



Reinstall cover on junction box

Title	Specification(s)	Objective(s)
6.6003.3c Fan mounting	<p>Fan outlet will be oriented toward the final termination location</p> <p>Fan will be oriented so the equivalent length of the duct run is as short as possible</p> <p>Fan will be mounted securely according to manufacturer specifications</p>	<p>Install mounting fan securely</p> <p>Ensure fan housing does not shake, rattle, or hum when operating</p>
6.6003.3d Weatherproof installation	<p>Exterior termination fitting will be flashed or weather sealed</p> <p>Water will be directed away from penetration</p> <p>Termination fitting installation will not inhibit damper operation</p> <p>Manufacturer specifications will be followed</p>	<p>Preserve integrity of the building <i>envelope</i></p> <p>Ensure a weather tight and durable installation</p> <p>Ensure unrestricted air flow</p>



Best Practice

Apply sealant behind termination cap, taking care to apply sealant to all edges



Best Practice

Termination is sealed and securely attached to the wall

Tools:

1. caulk gun
2. drill
3. drill bits
4. reciprocating saw
5. drywall saw or utility knife

Materials:

1. weatherproof termination kit
2. caulk or equivalent sealant
3. mechanical fasteners

Title	Specification(s)	Objective(s)
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6.6003.3d Weatherproof installation



1. Clean existing sealant to ensure proper adhesion to the surface



2. Once area around the termination opening is cleaned, apply sealant to all four sides of the opening



3. Install screws through the sealant, which will tighten the fitting and squeeze out excess sealant

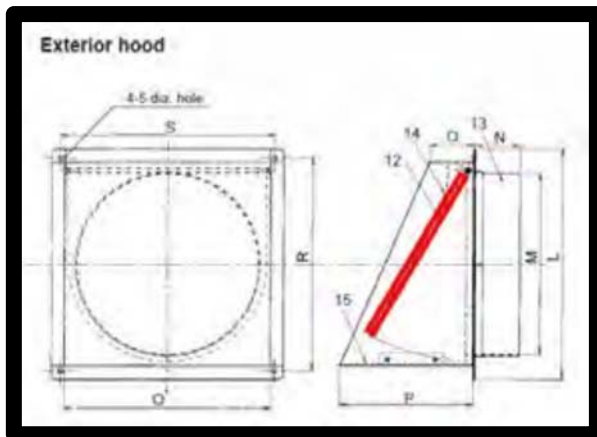


4. Wipe away excess sealant for a clean look



5. Ensure damper swings open freely, and closes with a tight fit

Title	Specification(s)	Objective(s)
6.6003.3e Backdraft damper	A <i>backdraft damper</i> will be installed between the outlet side of the fan and the exterior	Prevent reverse air flow when the fan is off



Best Practice

Damper should be installed to maintain exterior air barrier

6.6003.3f Fan housing seal	<p>Sealants will be compatible with their intended surfaces</p> <p>Sealants will be continuous and meet fire barrier specifications</p>	<p>Prevent air leakage through fan housing</p> <p>Ensure a permanent seal to the building <i>air barrier</i></p>
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Best Practice

Damper should be installed to maintain exterior air barrier

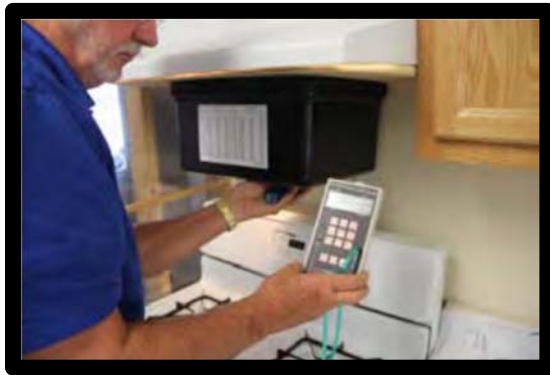
Tools:

1. caulk gun

Materials:

1. caulk

Title	Specification(s)	Objective(s)
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 <i>envelope</i> 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 <i>CFM</i> will be measured and adjusted to meet the design requirements	Exhaust sufficient air from desired locations to outside



Best Practice

Using a digital manometer, exhaust flow meter and fabricated cover, measure the fan flow



Best Practice

Air flow should be based on ASHRAE 62.2-2013 or local authority having jurisdiction

Tools:

1. exhaust fan flow meter
2. manometer

Materials:

1. a fabricated cover for fans larger than the flow meter

Title	Specification(s)	Objective(s)
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6.6003.3i Air flow



The exhaust fan flow meter won't fit most range hoods. A fabricated cover is needed



A fabricated cover can be used so long as the opening is smaller than the meter itself and larger than the E1 opening



With manometer properly set up, prepare to test air flow

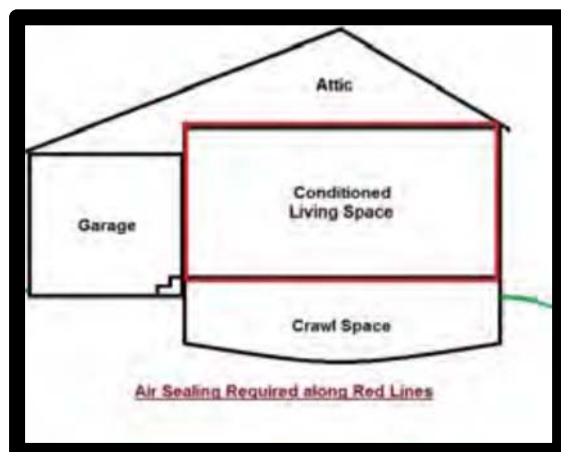


Fans must pull the required CFM according to ASHRAE. With the manometer Mode set to PR/FL, Device set to EXH, and Config set to E1, this fan pulls 111 CFM



If you reading this, congratulations on making it this far through the manual. Email wxtechteam@pct.edu with this page number to get a prize.

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
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Best Practice

The barrier between conditioned and unconditioned spaces should be sealed

See also SWS 3.1501.1 Air Sealing Garage Penetrations.

Title	Specification(s)	Objective(s)
6.6003.3k Combustion safety	<p>Pressure effects caused by fans will be assessed and corrected when found outside of combustion safety standards</p> <p>Make-up air will be provided in accordance with the current version of ASHRAE 62.2 and in compliance with the authority having jurisdiction.</p>	Ensure safe operation of combustion appliances



Before

Installing new ventilation can cause imbalances within the house



After

Test that depressurization limit is not being exceeded by new ventilation

Tools:

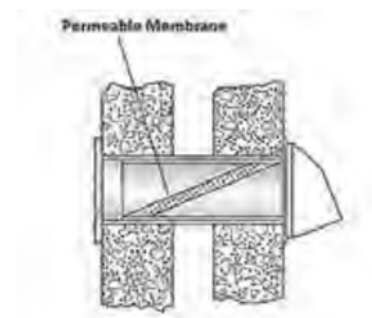
1. exhaust fan flow meter
2. manometer



1. Run depressurization testing on house to ensure new ventilation isn't causing unsafe conditions



2. If depressurization limit is exceeded, mitigate to eliminate safety risk



3. Mitigate safety risk with make-up air or other pressure relief



4. After mitigation, verify that depressurization limits are not being exceeded

See SWS 2.0299.1a-i for CAZ depressurization limits

6.6003.4 Multi-Port System

Topic: Exhaust

Subtopic: Fans

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 material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

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	<p>Fan outlet will be oriented toward the final termination location</p> <p>Fan will be oriented so the equivalent length of the duct run is as short as possible</p> <p>Fan will be mounted securely in accordance with manufacturer specifications</p> <p>Fan will be isolated from the building framing unless specifically designed to be directly attached</p> <p>Fan will be installed remotely by ducting from intake grilles</p>	<p>Ensure short duct runs to achieve optimum air flows</p> <p>Ensure mounting is installed securely</p> <p>Ensure fan housing or building framing does not shake, rattle, or hum when operating</p> <p>Minimize noise</p>
6.6003.4d Backdraft dampers (required in intermittent systems)	<p>A backdraft damper will be installed between the fan and the exterior unless the system operates continuously</p> <p>A backdraft damper will be installed in any duct serving any room with a separate exhaust (e.g., dryer)</p>	<p>Prevent reverse air flow when the system is off</p> <p>Prevent spread of contaminants between rooms</p>
PA WAP Guidance:	Avoid installing an exhaust port from a multi-port system in a room with an existing exhaust device.	
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

Title	Specification(s)	Objective(s)
6.6003.4f Duct connections	<p>Ducts will be connected and sealed to applicable intakes, collector box, fan, and termination fitting</p> <p>Ducts will be connected and sealed as follows:</p> <ul style="list-style-type: none"> • 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 <i>tie band</i> 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 <i>UL</i> 181B or 181B-M listed material 	<p>Exhaust air from desired locations to outside</p> <p>Preserve integrity of the duct system and building <i>envelope</i></p>
6.6003.4g Insulation	<p>All components outside of the thermal <i>envelope</i> will be insulated to a minimum of R-8 or equivalent to local code</p> <p>Exception: If system operates continuously, fan housing need not be insulated</p>	<p>Preserve integrity of the duct system</p>
6.6003.4h Boot to interior surface seal	<p>Sealants will be compatible with their intended surfaces</p> <p>Sealants will be continuous and meet fire barrier specifications</p>	<p>Prevent air leakage around boot</p> <p>Ensure a permanent seal to the building <i>air barrier</i></p> <p>Prevent a fire hazard</p>
6.6003.4i Air flow	<p>Air flows in <i>CFM</i> will be measured and adjusted to meet the design requirements</p>	<p>Exhaust sufficient air from desired locations to outside</p>
6.6003.4j Preventing air leakage caused by exhaust fans	<p>Air leakage into the house from other spaces will be prevented (e.g., garages, unconditioned crawl spaces, unconditioned attics)</p>	<p>Ensure occupant health and safety</p>
6.6003.4k Combustion safety	<p>Pressure effects caused by fans will be assessed and corrected when found outside of combustion safety standards</p>	<p>Ensure safe operation of combustion appliances</p>

6.6003.5 Garage Exhaust Fan

Topic: Exhaust

Subtopic: Fans

Desired Outcome: Contaminants properly removed from house

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

Title	Specification(s)	Objective(s)
6.6003.5a System selection	<p>Ventilation for garage will be exhaust only and provide a minimum installed capacity of 100 <i>CFM</i> of ventilation per vehicle bay and will vent directly outdoors</p> <p>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</p> <p>If a ducted fan (not through-the-wall) is used, measure and verify the minimum air flow and adjust as necessary</p>	<p>Remove contaminants from garage</p> <p>Reduce contaminant migration from garage to house</p> <p>Ensure occupant health and safety</p>
PA WAP Guidance:	SWS VARIANCE REQUESTED: Do not follow this SWS.	
6.6003.5b Air leakage	<p>Air leakage between the house and garages will be prevented by sealing and weather stripping</p>	<p>Ensure occupant health and safety</p> <p>Reduce conditioned air being drawn from the house</p> <p>Reduce contaminant migration from garage to house</p>
6.6003.5c Combustion safety	<p>Pressure effects caused by fans will be assessed and corrected when found outside of combustion safety standards</p> <p>Exhaust fans and other exhausting systems shall be provided with makeup air or other pressure relief</p>	<p>Ensure safe operation of combustion appliances</p> <p>Ensure occupant health and safety</p>

Subtopic 6.6005 Appliance Exhaust Vents

6.6005.1 Clothes Dryer

Topic: Exhaust

Subtopic: Appliance Exhaust Vents

Desired Outcome: Dryer air exhausted efficiently and safely

For supporting material, see [Calculation of the Infiltration Credit](#) and [Referenced Standards](#).

Title	Specification(s)	Objective(s)
6.6005.1a Clothes dryer ducting	<p>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</p> <p>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</p> <p>Dryer ducts exceeding 35' in duct equivalent length will have a dryer booster fan installed</p> <p>Plastic venting material will not be used</p> <p>Uninsulated clothes dryer duct will not pass through unconditioned spaces such as attics and crawl spaces</p> <p>Ducts will be connected and sealed as follows:</p> <ul style="list-style-type: none">• 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 <p>In addition:</p> <ul style="list-style-type: none">• Sheet metal screws or other fasteners that will obstruct the exhaust flow will not be used• Condensing dryers will be plumbed to a drain	<p>Preserve integrity of building envelope</p> <p>Effectively move air from clothes dryer to outside</p>

Title	Specification(s)	Objective(s)
6.6005.1a Clothes dryer ducting		



Before

Dryer is vented outside, but with the incorrect material.

Tools:

1. metal trimmers
2. drill



After

Dryer is vented outdoors, with correct material. Run is as short and straight as possible ensuring maximum flow.

Materials:

1. metal flex duct
2. dryer vent kit
3. hose clamps

Title	Specification(s)	Objective(s)
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6.6005.1a Clothes dryer ducting



1. Disconnect existing vent pipe from termination. If hose clamp is installed, save for reuse.



2. Disconnect existing vent pipe from dryer



3. Attach approved vent material to termination vent. Termination vent may need to be trimmed.



4. Trim metal vent to ensure the run is as short and straight as possible



5. Connect vent pipe to dryer



6. Dryer vents to outdoors, and exhaust damper is functional

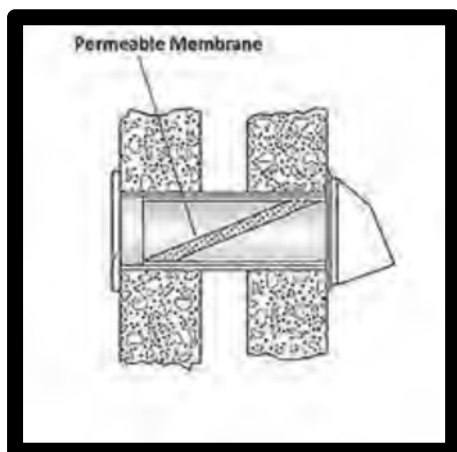


7. For vent runs >35 feet, a booster fan is required



8. Duct runs outside of conditioned space must be insulated and properly supported

Title	Specification(s)	Objective(s)
6.6005.1b Termination fitting	<p>Termination fitting manufactured for use with dryers will be installed</p> <p>A <i>backdraft damper</i> will be included, as described in termination fitting detail</p>	<p>Preserve integrity of building <i>envelope</i></p> <p>Effectively move air from clothes dryer to outside</p>
6.6005.1c Make-up air	<p>Make-up air will be provided in accordance with the current version of <i>ASHRAE</i> 62.2 and in compliance with the authority having jurisdiction</p>	<p>Preserve integrity of building <i>envelope</i></p> <p>Effectively move air from clothes dryer to outside</p>



Best Practice

A passive inlet vent can provide make-up air for dryer exhaust

Tools:

1. Drill
2. Hole saw
3. Caulk gun

Materials:

1. Caulk sealant
2. Fasteners

Title	Specification(s)	Objective(s)
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



Appliance exhaust, such as that for a dryer, can cause depressurization

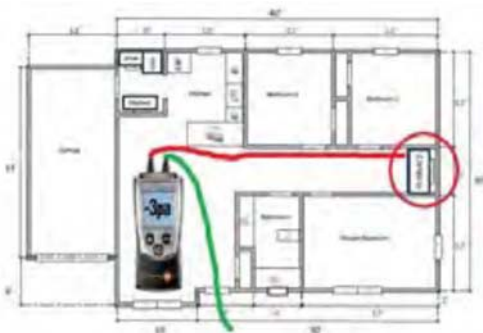


After

Test to verify combustion appliances are within depressurization limits

Tools:

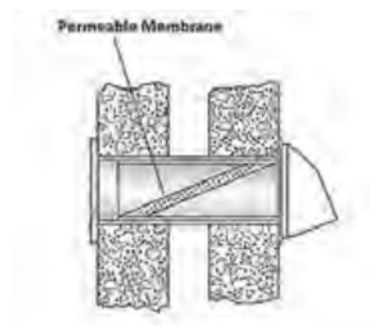
1. manometer



1. Run depressurization testing on house to ensure new ventilation isn't causing unsafe conditions



2. If depressurization limit is exceeded, mitigate to eliminate safety risk



3. Mitigate safety risk by installing make-up air, such as a passive inlet vent, or other pressure relief



4. After mitigation, verify that depressurization limits are not being exceeded

See SWS 2.0299.1a-i for CAZ depressurization limits

Title	Specification(s)	Objective(s)
6.6005.1e Occupant education	<p>Occupant will be instructed to keep lint filter and termination fitting clean</p> <p>Occupant will be instructed to keep dryer booster fan clean, if present</p> <p>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)</p>	Effectively move air from clothes dryer to outside



Unsafe

Neglect of clothes dryer maintenance can cause fire hazards



Best Practice

Occupants should be taught to clean lint filters and termination fittings



In homes with booster fans, occupant should know location and how to clean



Occupants should be taught never to put flammable articles in dryer (in this case, oily rags)

6.6005.2 Kitchen Range

Topic: Exhaust

Subtopic: Appliance Exhaust Vents

Desired Outcome: Kitchen range fan installed to specification

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

For supporting material, see [Calculation of the Infiltration Credit](#) and [Referenced Standards](#).

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 Recirculating fans will not be used as a ventilating device	Remove cooking contaminants from the house Preserve integrity of building envelope



Before

Recirculating fans over ranges do not actually remove contaminants

Title	Specification(s)	Objective(s)
6.6005.2c Fan ducting	<p>Kitchen range fans will be ducted to the outdoors</p> <p>As short a run as practical of smooth wall metal duct will be used, following manufacturer specifications</p> <p>Ducting will be connected and sealed as follows:</p> <ul style="list-style-type: none"> • 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 	<p>Preserve integrity of building envelope</p> <p>Effectively move air from range to outside</p>
PA WAP Guidance:	Where SWS 6.6005.2c <i>Fan Ducting</i> references PVC, see the IRC M1503.2 exception for full detail.	



Tools:

1. Drill
2. Putty knife
3. Tape measure
4. Metal snips
5. Saw

Materials:

1. Round metal ducting
2. Mastic
3. Fiberglass mesh tape
4. Fasteners

Before

Exhaust duct should be smooth-walled and in as short a run as possible

See also 6.6002.1d.

Note: Only smooth-wall metal duct will be used, except for down-draft exhaust systems where PVC is acceptable as well. Flex duct is NOT acceptable for kitchen fan exhaust application.

Title	Specification(s)	Objective(s)
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6.6005.2c Fan ducting



1. Duct run should be as smooth and short as possible



2. Duct should be fastened securely with three evenly-spaced screws



3. Joints should be secured with fiberglass tape



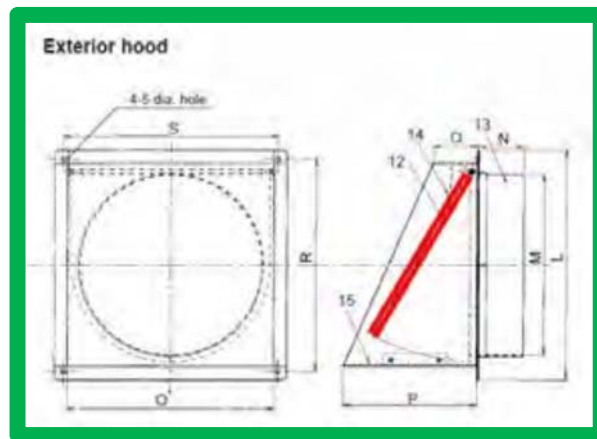
4. Finally, joints should be secured with UL-181 mastic

Title	Specification(s)	Objective(s)
6.6005.2d Termination fitting	Termination fitting will be installed including a <i>backdraft damper</i> , as described in termination fitting detail	<p>Ensure safe operation of combustion appliances</p> <p>Ensure occupant health and safety</p>



Before

Kitchen fans should exhaust to the exterior, not just recirculate air



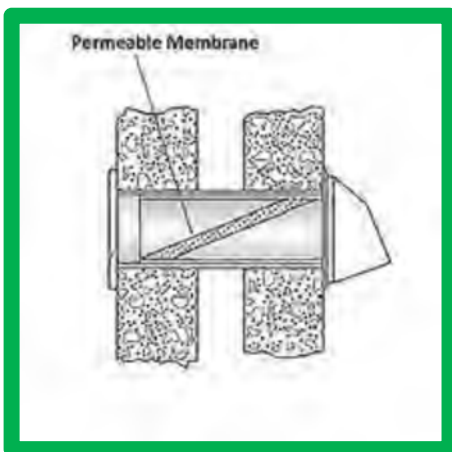
After

Exhaust fans should have backdraft dampers



Backdraft damper on roof mounted exhaust fan

Title	Specification(s)	Objective(s)
6.6005.2e Make-up air	Make-up air will be provided in accordance with the current version of ASHRAE 62.2 and in compliance with the authority having jurisdiction	Ensure safe operation of combustion appliances Ensure occupant health and safety
PA WAP Guidance:	See IRC M1503.4.	



After

A passive inlet vent can provide make-up air for dryer exhaust

Tools:

1. Drill
2. Hole saw
3. Caulk gun

Materials:

1. Caulk sealant
2. Fasteners

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
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After

Kitchen exhaust fans can cause combustion appliances to depressurize. Test that combustion appliance are operating within depressurization limit.

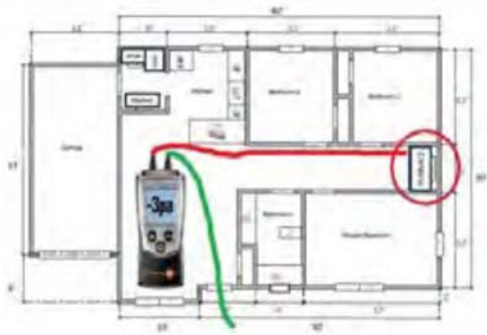
Tools:

1. Manometer

See SWS 2.0299.1a-i for CAZ depressurization limits

Title	Specification(s)	Objective(s)
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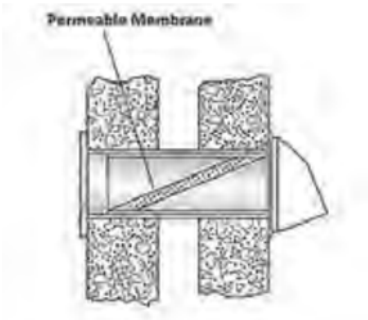
6.6005.2f Combustion safety



1. Run depressurization testing on house to ensure new ventilation isn't causing unsafe conditions



2. If depressurization limit is exceeded, mitigate to eliminate safety risk



3. Install a source of make-up air, such as a passive inlet vent



4. After mitigation, verify that depressurization limits are not being exceeded

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
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Topic 6.61 Supply

Subtopic 6.6102 Components

6.6102.1 Outside Air Ventilation Supply Ducts

Topic: Supply

Subtopic: Components

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

For supporting material, see [Referenced Standards](#).

Title	Specification(s)	Objective(s)
6.6102.1a 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
PA WAP Guidance:	This SWS requires a duct pressurization test.	
6.6102.1b Duct insulation	Ventilation supply ducts installed outside of the thermal <i>envelope</i> 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

Title	Specification(s)	Objective(s)
6.6102.1d Duct connections	<p>All connections will have a contact overlap of at least 1"</p> <p>Ducts will be connected and sealed as follows:</p> <ul style="list-style-type: none"> • 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 <i>tie band</i> 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 <p>Outdoor air ventilation supply ducts attached to the return side of forced air systems will be:</p> <ul style="list-style-type: none"> • Attached as close to the heating, ventilation, and air conditioning (<i>HVAC</i>) systems fan as possible while remaining in compliance with manufacturer specifications • Set up to provide filtration of outdoor ventilation air before reaching the <i>HVAC</i> system (for minimum <i>MERV</i> 6 filter) • Attached via a mechanically fastened takeoff collar <p>All joints and connections in ductwork will be fastened and sealed with UL181B or 181B-M welds, gaskets, adhesive mastics, or mastic-plus-embedded-fabric systems</p>	<p>Effectively move the required volume of air</p> <p>Preserve integrity of the ventilation supply duct system and building <i>envelope</i></p>
6.6102.1e Duct materials	<p>Flexible air duct material will meet <i>UL</i> 181, <i>NFPA</i> 90A/90B, International Mechanical Code, or the Uniform Mechanical Code</p>	<p>Effectively move the required volume of air</p> <p>Preserve integrity of the duct system and building <i>envelope</i></p>
6.6102.1f Outdoor air intake location	<p>Outdoor air intake will be installed in accordance with the following:</p> <ul style="list-style-type: none"> • A minimum of 6" from grade • A minimum of 10' from contaminant sources or exhaust outlets • Above local snow or flood line • A minimum of 18" above an asphalt based roof • Never on a flat roof • As required by authority having jurisdiction 	<p>Prevent contaminants from entering house</p> <p>Ensure unrestricted air flow</p>

6.6102.2 Intakes

Topic: Supply

Subtopic: Components

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

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

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 <i>envelope</i> 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

Title	Specification(s)	Objective(s)
6.6102.2e Connection to intake fitting	<p>Duct to intake fitting will be connected and sealed as follows:</p> <ul style="list-style-type: none"> • 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 <i>tie band</i> tensioning tool • Flexible duct between <i>tie band</i> 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 <i>UL</i> 181B or 181B-M listed material <p>Ensure fasteners do not inhibit intake damper operation</p>	<p>Preserve integrity of the building <i>envelope</i></p> <p>Ensure a weather tight and durable intake installation</p> <p>Ensure unrestricted air flow</p>
6.6102.2f Weatherproofing	<p>Exterior termination fitting will be flashed or weather sealed</p> <p>Water will be directed away from penetration Installation will not inhibit damper operation</p> <p>Manufacturer specifications will be followed</p>	<p>Preserve integrity of the building <i>envelope</i></p> <p>Ensure a weather tight and durable intake installation</p> <p>Ensure unrestricted air flow</p>
6.6102.2g Pest exclusion	<p>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</p> <p>Screen will be installed so it does not inhibit intake damper operation</p>	<p>Prevent pest entry</p> <p>Ensure unrestricted air flow</p>
6.6102.2h Intake location	<p>Intake will be installed according to the following:</p> <ul style="list-style-type: none"> • A minimum of 6" from grade • A minimum of 10' from contaminant sources or exhaust outlets • Above local snow or flood line • A minimum of 18" above an asphalt based roof • Never on a flat roof • As required by authority having jurisdiction 	<p>Prevent contaminants from entering house</p> <p>Ensure unrestricted air flow</p>

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

Topic: Supply

Subtopic: Components

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

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

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

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

Title	Specification(s)	Objective(s)
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 (<i>MERV</i>) 6 or better when tested in accordance with <i>ANSI / ASHRAE</i> 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 <i>envelope</i>
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 <i>envelope</i>

Subtopic 6.6103 Fans

6.6103.1 Inline or Multi-Port

Topic: Supply

Subtopic: Fans

Desired Outcome: Inline or multi-port fan installed in accordance with specifications

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

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

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 <i>service switch</i> will be accessible for maintenance, service, and replacement in accordance with applicable code or authority having jurisdiction	Ensure accessibility for maintenance

Title	Specification(s)	Objective(s)
6.6103.1c Fan mounting	<p>Fan will be oriented with inlet toward the fan intake fitting</p> <p>Fan will be oriented so the equivalent length of the duct run is as short as possible</p> <p>Fan will be securely mounted in accordance with manufacturer specifications</p> <p>Fan will be isolated from the building framing unless specifically designed to be directly attached</p> <p>Fan will be installed remotely by ducting from supply register or grilles</p>	<p>Ensure short duct run to achieve optimum air flow</p> <p>Ensure fan is mounted securely</p> <p>Ensure fan housing or building framing does not shake, rattle, or hum when operating</p> <p>Minimize noise</p>
6.6103.1d Damper (required for intermittent operation)	<p>Damper will be installed to open in the direction of the desired flow</p> <p>Damper will close when system is off</p>	<p>Ensure unrestricted air flow</p>
6.6103.1e Duct connections	<p>Ducts will be connected and sealed to the intake fitting, fan, and register or grilles as follows:</p> <ul style="list-style-type: none"> • 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 <i>tie band</i> 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 <p>All joints and connections in ductwork will be fastened and sealed with <i>UL</i> 181B or 181B-M welds, gaskets, adhesive mastics, or mastic-plus-embedded-fabric systems</p>	<p>Provide desired air flow</p> <p>Preserve integrity of the duct system and building <i>envelope</i></p>
6.6103.1f Filter	<p>An accessible filter will be installed between the intake fitting and the fan</p> <p>Contaminant removal will be consistent with at least minimum efficiency reporting value (<i>MERV</i>) 6 or better when tested in accordance with <i>ANSI</i> / <i>ASHRAE</i> 52.2</p> <p>Filter or air cleaning systems that intentionally produce ozone will not be allowed</p>	<p>Ensure occupant health and safety</p> <p>Preserve integrity of the building <i>envelope</i></p>

Title	Specification(s)	Objective(s)
6.6103.1g Occupant education	Occupant will be educated on how and when to change filter	Ensure occupant health and safety
6.6103.1h Boot to interior surface seal	<p>All gaps between boot and interior surface will be air sealed</p> <p>Gypsum edge will be wetted before applying water-based sealant</p> <p>Sealants will be continuous and be in accordance with 2012 IRC R302.9</p>	<p>Prevent air leakage around intake housing</p> <p>Ensure a permanent seal to the building air barrier</p> <p>Prevent a fire hazard</p>

Subtopic 6.6188 Special Considerations

6.6188.1 Removing Supply Vents from Garages

Topic: Supply

Subtopic: Special Considerations

Desired Outcome: Safe removal of supply garage vents

Title	Specification(s)	Objective(s)
6.6188.1a Removal of supply/return in garage	<p>Supply run feeding the register will be truncated as near to the supply plenum as possible</p> <p>If directly connected to the plenum, it will be truncated at the plenum</p> <p>If connected to a Y or T branch system, it will be truncated at the Y or T</p> <p>Return grille located in garage will be removed in the same manner as supply</p>	Minimize surface area of duct
6.6188.1b Patching of the hole in the duct system created by removal	<p>All holes in sheet metal ducts will be patched with sheet metal and secured with sufficient screws to hold the patch flat without gaps</p> <p>Holes left in any Y or T will be capped with sheet metal caps and fastened with at least three screws</p>	Ensure a secure and strong patch
PA WAP Guidance:	Be sure to use compatible materials to existing materials and application for patch work.	

Title	Specification(s)	Objective(s)
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
PA WAP Guidance:	Test at the HVAC unit.	

Topic 6.62 Whole Building Ventilation

Subtopic 6.6201 Air Flow Requirements

6.6201.1 Installed System Air Flow

Topic: Whole Building Ventilation

Subtopic: Air Flow Requirements

Desired Outcome: Installed system air flow meets required standard

For supporting material, see [Calculation of the Infiltration Credit](#) and [Referenced Standards](#).

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 current version of ASHRAE 62.2 and in compliance with the authority having jurisdiction. See Calculation of the Infiltration Credit for calculation information and examples	Provide sufficient flows in accordance with current ventilation standards
6.6201.1b Separate exhaust for all baths and kitchens sufficient to meet primary ventilation requirements	Air flows will be measured and adjusted to meet the current version of ASHRAE 62.2 and in compliance with the authority having jurisdiction. See Calculation of the Infiltration Credit for calculation information and examples	Provide sufficient flows per current ventilation standards
6.6201.1c Single additional fan to meet all ventilation requirements	Air flows will be measured and adjusted to meet the current version of ASHRAE 62.2 and in compliance with the authority having jurisdiction. See Calculation of the Infiltration Credit for calculation information and examples	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

Desired Outcome: Air circulates freely between rooms

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

Title	Specification(s)	Objective(s)
6.6201.2a Balancing pressure	<p>An appropriate means of pressure balancing will be installed (e.g., transfer grilles, jumper ducts, individual room returns)</p> <p>No room will exceed ± 3 pascals with reference to the outdoors with all interior doors closed and ventilation systems running</p>	<p>Ensure free flow of air between rooms</p> <p>Preserve integrity of the building <i>envelope</i></p>



Before

If reading is $> \pm 3$ pa, interior ventilation needs to be installed



After

Passive door vents and individual room returns are two possibilities



1. With interior doors open, put reference hose to exterior. Take baseline reading.



2. Turn on exhaust fans and close interior doors



3. With hose under door, check pressure again. Readings $> \pm 3$ pa are not good and require interior ventilation.

Subtopic 6.6202 Components

6.6202.1 Controls

Topic: Whole Building Ventilation

Subtopic: Components

Desired Outcome: Fan controls support ventilation strategy

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

Title	Specification(s)	Objective(s)
6.6202.1a Primary ventilation fan (whole-house volume)	Controls will be used that can meet the following conditions: <ul style="list-style-type: none">• 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: <ul style="list-style-type: none">• 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

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.

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
PA WAP Guidance:	Or per manufacturer's instructions	

Title	Specification(s)	Objective(s)
6.6202.2e Installation of fittings	<p>Collar will be at least the same diameter as the exhaust fan outlet; if collar is larger than exhaust fan outlet, a rigid metal transition will be used</p> <p>Fitting will be appropriate for regional weather conditions and installation location on house so as not to be rendered inoperable</p>	<p>Achieve the desired air flows to and from the designated locations</p> <p>Ensure unrestricted air flow</p> <p>Preserve integrity of the building <i>envelope</i></p>
6.6202.2f Duct connections	<p>Ducts will be connected to applicable registers or grilles, collector box, <i>HRV</i> or <i>ERV</i>, intake fitting, and termination fitting</p> <p>Ducts will be connected and sealed as follows:</p> <ul style="list-style-type: none"> • 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 <i>tie band</i> tensioning tool • Flexible duct between <i>tie band</i> 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 <i>UL</i> 181B or 181B-M listed material 	<p>Achieve the desired air flows to and from the desired locations</p> <p>Preserve integrity of the duct system and building <i>envelope</i></p>
6.6202.2g Duct layout	<p>Air to be exhausted to the outdoors will not be taken directly from the forced air system</p> <p>Supply ducts attached to the return side of forced air systems will be:</p> <ul style="list-style-type: none"> • Attached as close to the <i>HVAC</i> system's fan as possible while remaining in compliance with manufacturer specifications • Set up to provide filtration of outdoor ventilation air before reaching the <i>HVAC</i> system with minimum <i>MERV</i> 6 filter • Connected to the intake fitting • Connected and sealed in accordance with the supply duct detail 	<p>Achieve the desired air flows to and from the desired locations</p> <p>Preserve integrity of duct system and house</p> <p>Ensure occupant health and safety</p>
6.6202.2h Insulation	<p>Ducts installed outside of the thermal <i>envelope</i> will be insulated to a minimum of R-8 or equivalent to local codes</p>	<p>Preserve integrity of the duct system by eliminating condensation</p>

Title	Specification(s)	Objective(s)
6.6202.2i Sealant selection	<p>Gap between registers or grilles and interior surface will be sealed</p> <p>Sealants will be compatible with their intended surfaces</p> <p>Sealants will be continuous and meet fire barrier specifications</p>	<p>Prevent air leakage around registers or grilles</p> <p>Ensure a permanent seal</p> <p>Prevent a fire hazard</p>
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	<p>Ensure occupant health and safety</p> <p>Preserve integrity of system</p>

Subtopic 6.6203 Dehumidifiers

6.6203.1 Ventilator Dehumidifiers

Topic: Whole Building Ventilation

Subtopic: Dehumidifiers

Desired Outcome: Humidity controlled to achieve optimum indoor air quality ([IAQ](#))

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

PA WAP Guidance: 6.6203.1 Ventilator Dehumidifiers	Note: Ventilator dehumidifiers are not stand-alone dehumidifiers; they are combo units not normally used in PA.
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Title	Specification(s)	Objective(s)
6.6203.1a Equipment	<p>Equipment will be ENERGY STAR® rated</p> <p>Settings will be maintained through power failure (auto restart)</p> <p>Dehumidification ventilator will be a ducted unit</p> <p>Dehumidification ventilator will be able to provide outside air</p>	<p>Efficiently remove humidity</p> <p>Ensure ease of operation</p> <p>Provide ventilation with outside air</p>

Title	Specification(s)	Objective(s)
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

Subtopic 6.6288 Special Considerations

6.6288.1 Sound-Rating Limits

Topic: Whole Building Ventilation

Subtopic: Special Considerations

Desired Outcome: Systems operate as quietly as possible

For supporting material, see [Calculation of the Infiltration Credit](#) and [Referenced Standards](#).

Title	Specification(s)	Objective(s)
6.6288.1a Primary ventilation system or any continuously operating fan	System shall be rated for sound in accordance with current ASHRAE 62.2 standard	Minimize noise
6.6288.1b Intermittent local ventilation system	Local ventilation will be rated for sound at a maximum of 3 sone, unless their maximum rated airflow exceeds 400 cfm , in accordance with ASHRAE 62.2-2010	Minimize noise
PA WAP Guidance:	If replacing an existing fan, be sure to comply with sound ratings for ASHRAE 62.2-2013.	

Topic 6.99 Additional Resources

Subtopic 6.9901 Codes and Standards Resources

6.9901.1 Supplemental Ventilation Information—ASHRAE 62.2

Topic: Additional Resources

Subtopic: Codes and Standards Resources

Desired Outcome: To provide supplemental ventilation information—ASHRAE 62.2

For supporting material, see [Calculation of the Infiltration Credit](#) and [Referenced Standards](#).

Title	Specification(s)	Objective(s)
6.9901.1a Ventilation fan flow rate	<i>ASHRAE</i> Standard 62.2-2013 and the calculation of the <i>infiltration</i> credit allow adjustments to primary ventilation fan flow rates for existing houses using a single fan.	To provide supplemental ventilation information-- <i>ASHRAE</i> 62.2

Chapter 7: Baseload

PA WAP approved baseload measures include lighting, refrigerators, and unsafe or leaking water heaters. Clothes dryer venting improvement, hot water saving measures. Refrigerators and all other appliances should be leveraged through a local utility program whenever possible.

Lighting

CFL replacement in incandescent bulbs used 2 hours per day or more including outside and halogen torchieres.

Water Heater Replacement

Unsafe or leaking water heaters may be replaced with a sealed combustion, electric, or fossil fuel-fired water heater. Replacement and installation of appliances other than water heaters, such as stoves or washing machines, is not allowable with DOE funds. Repair and cleaning of water heaters and minor cleaning of other appliances is allowed if necessary to perform weatherization measures.

Combustion safety testing is required when combustion appliances are present.

Hot Water Saving Measures

7.8103.1c

Insulate all hot water lines that are accessible, as long as it meets an SIR of 1 or greater.

Clothing Dryers

Proper venting to the exterior of structure for combustion appliances, including gas dryers is required.

Refrigerator Replacement

Reference the Kouva-Cavallo website to find refrigerator info. New refrigerator must get an SIR of 1 or more in the standardized energy audit. The cost of replacement must include the proper decommissioning costs for the existing refrigerators.

Only one refrigerator per home may be replaced.

If eligible for replacement, the client must sign a release statement and agree to trade the old unit for the new unit. The agreement should include a hold-harmless clause for damages during delivery.

If the client is a renter, the landlord must verify ownership of the existing refrigerator and acknowledge that the replacement will be the property of same owner.

The refrigerator replacement model should be comparable in size. However, if the client is willing to trade in more than one unit, they are eligible for the next size larger replacement model.

Upright, chest and freezer-only appliances are not eligible for replacement. If, however, a client owns an inefficient 15 cubic foot refrigerator/freezer and a stand-alone freezer only, the agency may replace both units with a new 18-21 cubic foot refrigerator/freezer unit if the energy savings compared to both existing units justify the measure.

Side-by-side or bottom-freezer refrigerators may only be installed if there is adequate justification and documentation depicting that type of refrigerator was already present and/or the client has a disability which would require that type of refrigerator. This documentation must include photographs taken within the dwelling unit clearly indicating the existing side-by-side or bottom-freezer refrigerator and/or a client sign-off which indicates that the client requires either a side-by-side or bottom-freezer refrigerator due to a disability.

Documentation must include proof of proper decommissioning of the existing refrigerator according to EPA Guidelines. Such proof may be a note from the organization doing the decommissioning, a copy of the contract for decommissioning, or some other documentation indicating that the refrigerator (or all refrigerators) are properly decommissioned.

Adhere to the baseload-related topics referenced in the *DCED Directive: Health and Safety*.

Crosswalk of Baseload SWS with the ANSI/BPI 1100 Energy Auditing Standard

The SWS for Health and Safety will apply to Auditors as they follow the ANSI-BPI-1100-T-2014 Home Energy Auditing Standard sections 1, 12 and 13.

7. Baseload SWS

Topic 7.80 Plug Load

Subtopic 7.8001 Refrigerators/Freezers

7.8001.1 Refrigerator and Freezer Replacement

Topic: Plug Load

Subtopic: Refrigerators/Freezers

Desired Outcome: A more energy efficient appliance installed

For supporting material, see [Referenced Standards](#).

PA WAP Guidance: 7.8001.1 Refrigerator and Freezer Replacement	Refer to PA WAP Field Manual, Chapter 7 Baseload for policy on replacement.
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Title	Specification(s)	Objective(s)
7.8001.1a Selection	Appliance shall be ENERGY STAR® rated Appliance will fit in the available space without blocking access to light switches, cabinets, etc. Appliance will carry a minimum one-year warranty that will provide a replacement appliance if repeated issues relating to health, safety, or performance occur	Energy efficient appliance installed
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

Title	Specification(s)	Objective(s)
7.8001.1c Decommissioning	<p>Appliances replaced by new units will be recycled or disposed of in accordance with federal, state, or local regulations</p> <p>Appliances infested with pests will be enclosed before moving</p>	<p>Prevent reuse of inefficient equipment and components</p> <p>Protect the environment</p> <p>Protect worker safety</p>

7.8001.2 Cleaning and Tuning Existing Refrigerators and Freezers

Topic: Plug Load

Subtopic: Refrigerators/Freezers

Desired Outcome: Energy used for food preservation reduced

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

Title	Specification(s)	Objective(s)
7.8001.2a Clean and tune	<p>Dirty or clogged coils will be cleaned</p> <p>Air flow to the coils will be provided in accordance with manufacturer specifications</p> <p>Appliance will be located away from heat sources (e.g., supply registers, direct sunlight) if possible</p> <p>Interior temperatures will be measured, and the appliance must maintain:</p> <ul style="list-style-type: none"> Freezer temperature at 0° Fresh food at 35-40° <p>Specific information about the proper maintenance of the equipment will be provided to the occupant</p> <p>Condensation control switch will be left in the appropriate position, given occupant preference and moisture load in the house</p>	<p>Reduce energy use</p> <p>Improve performance</p> <p>Educate occupant on how to operate and maintain the appliance</p>

Subtopic 7.8002 Electronics

7.8002.1 Entertainment and Computer Systems and Components Replacement

Topic: Plug Load

Subtopic: Electronics

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

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

PA WAP Guidance: 7.8001.1 Refrigerator and Freezer Replacement	Electronics are not an allowable measure in PA. Do not apply the SWS's in Subtopic 7.8002 Electronics. Provide client education on reducing energy consumption of electronics, such as equipment controls, enabling energy saving features on computers, selecting ENERGY STAR® equipment or appliances, and other behavioral methods to reduce energy consumption.
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Subtopic 7.8003 Lighting

7.8003.1 Lighting Upgrade

Topic: Plug Load

Subtopic: Lighting

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

For supporting material, see [Calculation of the Infiltration Credit](#) and [Referenced Standards](#).

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)
PA WAP Guidance:	Provide client education.	

Title	Specification(s)	Objective(s)
7.8003.1b Selection	<p>All bulbs, fixtures, and controls will be appropriate for the intended application (e.g., enclosed, orientation, dimmable, potential for breakage, indoor, and outdoor)</p> <p>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)</p> <p>Selected equipment should have the highest level of efficiency within a technology [e.g., compact fluorescent lamp (CFL), LED]</p> <p>All bulbs, fixtures, and controls will be ENERGY STAR® rated where applicable</p> <p>When possible, bulbs, fixtures, and controls will be selected that will facilitate the use of future lighting technologies (e.g., LEDs)</p> <p>When incandescent bulbs cannot be replaced or when occupant chooses not to replace, a dimmer will be selected</p> <p>Light/lamp wattage should not exceed rated wattage of fixture</p> <p>Bulb replacements will be chosen based on expected durability, light quality, and lifetime energy use of the bulb</p> <p>Controls to turn off lights when not needed (e.g., no one in room) will be provided</p> <p>All bulbs, fixtures, and controls will be UL -approved and installed in accordance with local code(s) and NFPA 70 National Electric Code</p> <p>Fluorescent light ballasts containing polychlorinated biphenyls (PCBs) will be replaced in accordance with the EPA 's Healthy Indoor Environment Protocols for Home Energy Upgrades</p>	<p>Provide improved lighting quality at lower energy use</p> <p>Select equipment that will not be an unnecessary barrier to future technologies</p> <p>Avoid inferior products and unsatisfied occupants</p>

Subtopic 7.8004 Laundry

7.8004.1 Washing Machine

Topic: Plug Load

Subtopic: Laundry

Desired Outcome: Energy and environmental impact for washing clothes reduced

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

For supporting material, see [Calculation of the Infiltration Credit](#) and [Referenced Standards](#).

Title	Specification(s)	Objective(s)
7.8004.1a Selection	<p>Minimum appliance efficiency will be ENERGY STAR® and WaterSense® or better</p> <p>Classes within ENERGY STAR® standards will be considered so as to achieve greater savings</p> <p>Adequate clearance will be maintained around appliance when fit into available space so access to cabinets and light switches are not blocked</p> <p>Appliance will be covered by a minimum one-year warranty</p> <p>Equipment will be selected with features that reduce peak electric demand, absolute energy use, and water use</p> <p>Standby losses for equipment will be one watt or less</p>	<p>Reduce energy use</p> <p>Ensure occupant satisfaction with appliance</p>
PA WAP Guidance:	Washing machine replacement is not an allowable measure in PA. Provide client education regarding washing machines.	

Title	Specification(s)	Objective(s)
7.8004.1b Installation	<p>Appliance will be installed in accordance with manufacturer specifications (e.g., leveling, plumbing connection, electrical connection, interior lighting) and meet all applicable codes</p> <p>Shut-off valves will be installed if not already present</p> <p>Hoses that can withstand water pressure at the location will be installed</p> <p>If located in conditioned or finished area, overflow pan will be installed and drained to a safe location</p> <p>Any penetrations to the exterior of the home created by the installation of the appliance will be sealed</p> <p>Energy-related appliance controls will be demonstrated to the occupant</p> <p>Specific information about proper maintenance of the equipment will be provided to the occupant</p> <p>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</p> <p>Warranty information, operation manuals, and installer contact information will be provided to the occupant</p>	<p>Ensure equipment functions as designed</p> <p>Reduce water consumption</p> <p>Prevent water damage</p> <p>Educate occupants on how to maintain washer to ensure savings</p>
PA WAP Guidance:	Washing machine replacement is not an allowable measure in PA. Provide client education regarding washing machines.	
7.8004.1c Decommissioning	<p>Replaced appliances will be recycled or removed in accordance with local regulations, including older equipment switches containing mercury</p>	<p>Prevent the reuse of inefficient equipment and its components</p> <p>Reduce waste</p> <p>Ensure occupant health</p>
PA WAP Guidance:	Washing machine replacement is not an allowable measure in PA. Provide client education regarding washing machines.	

7.8004.2 Clothes Dryer Replacement

Topic: Plug Load

Subtopic: Laundry

Desired Outcome: Energy and environmental impact for drying clothes reduced

For supporting material, see [Calculation of the Infiltration Credit](#) and [Referenced Standards](#).

Title	Specification(s)	Objective(s)
7.8004.2a Selection	<p>Total energy use will be factored into the selection process if fuel switching is being considered</p> <p>Dryer will be equipped with moisture sensor</p> <p>Equipment will be selected with energy features that reduce both peak electric demand and absolute energy use</p> <p>Standby losses for equipment will be one watt or less</p> <p>A dryer best matched to the venting options will be selected (e.g., central location, length of vent, cost of venting)</p> <p>Appliance will be covered by a minimum one-year warranty</p>	<p>Reduce energy use</p> <p>Avoid increasing total energy use (gas and electric) when fuel switching</p>
PA WAP Guidance:	Clothes dryer replacement is not an allowable measure in PA. Provide client education regarding clothes dryer efficiency and safety.	

Title	Specification(s)	Objective(s)
<p>7.8004.2b Installation</p>	<p>Appliance will be installed in accordance with manufacturer specifications (e.g., leveling, plumbing connection, electrical connection, interior lighting) and meet all applicable codes</p> <p>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:</p> <ul style="list-style-type: none"> • Appliance will be vented to the outside using metal-to-metal or <i>UL</i> listed foil-type venting material • Venting design will meet standards for optimal venting • Venting will not be constricted or blocked and should be free of lint and/or debris • Must be mechanically fastened to connect metal-to-metal and must not catch lint inside venting material • Only clamps will be used on semi-rigid metal and <i>UL</i> listed foil-type venting materials • <i>Pest screen will be installed at the termination</i> • At least 3' of the vent closest to the exterior of the house will be insulated with a minimum of R-6 <p>All dryers, other than condensing dryers, will be vented to the outdoors</p> <p>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</p> <p>Any penetrations to the exterior of the home created by the installation of the appliance will be sealed</p> <p>Energy-related appliance controls will be demonstrated to the occupant</p> <p>Specific information of the proper maintenance of the equipment will be provided to the occupant</p> <p>Warranty information, operation manuals, and installer contact information will be provided to the occupant</p>	<p>Ensure equipment functions as designed</p> <p>Install appliance safely and effectively</p> <p>Ensure house as a whole system is not adversely affecting the proper functioning/venting of equipment</p> <p>Reduce energy use</p> <p>In case of fuel switching, reduce cost</p>
<p>PA WAP Guidance:</p>	<p>VARIANCE REQUESTED: Do not install a pest screen at the termination of dryer vents. Per 2012 IRC, page 507: Exhaust duct terminations shall be equipped with a backdraft damper. Pest screens shall NOT be installed at the duct termination.</p>	

Title	Specification(s)	Objective(s)
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
PA WAP Guidance:	Clothes dryer replacement is not an allowable measure in PA. Provide client education regarding clothes dryer efficiency and safety.	

Topic 7.81 Water Heating

Subtopic 7.8101 Water Use Reduction

7.8101.1 Shower Head and Faucet Aerator

Topic: Water Heating

Subtopic: Water Use Reduction

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

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

Title	Specification(s)	Objective(s)
7.8101.1a Work assessment	Installer 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	<p>The rated flow of new shower heads will be 2.5 gallons per minute (<i>GPM</i>) or less</p> <p>If multiple heads are provided, the total flow rate will not exceed 2.5 <i>GPM</i></p> <p>Aerator flow rate will be 2.2 <i>GPM</i> or less</p> <p>Features will be selected that meet any special needs of the occupant (e.g., shut off, swivel, handheld showers)</p>	<p>Reduce water and energy consumption</p> <p>Ensure occupant satisfaction</p>

Title	Specification(s)	Objective(s)
7.8101.1c Installation	<p>Equipment will be installed in accordance with manufacturer specifications and meet all applicable building codes</p> <p>Water quality will be evaluated for debris that may clog the equipment</p> <p>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</p> <p>If needed, shower diverter will be repaired or replaced</p> <p>Any penetrations to the exterior of the home created by the installation of the equipment will be sealed</p> <p>Any damage done to the house during installation will be repaired</p> <p>Specific information about proper maintenance of the equipment will be provided to the occupant</p> <p>Warranty information, operation manuals, and installer contact information will be provided to the occupant</p> <p>Water flow that satisfies the occupant will be provided by all shower heads and faucet aerators</p> <p>Occupant's acceptance of the shower head and/or aerator will be documented</p>	<p>Reduce water and energy consumption</p> <p>Ensure occupant satisfaction with water flow</p> <p>Eliminate water leakage</p> <p>Prevent water damage</p>
7.8101.1d Decommissioning	<p>Replaced shower heads and faucet aerators will be recycled or disposed of properly</p>	<p>Prevent the reuse of inefficient equipment and components</p>

Subtopic 7.8102 Installation and Replacement

7.8102.1 Water Heater Selection

Topic: Water Heating

Subtopic: Installation and Replacement

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

For supporting material, see [Calculation of the Infiltration Credit](#) and [Referenced Standards](#).

Title	Specification(s)	Objective(s)
7.8102.1a Selection parameters	<p>Equipment will provide sufficient, affordable, safe, and healthy hot water for the occupant in accordance with 2012 IRC P2801</p> <p>Potential for solar hot water heating or other renewable energy systems will be assessed in selecting the hot water equipment</p> <p>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</p> <p>If a combustion based system is selected, it will be either direct vented or power vented, and ENERGY STAR® qualified or an Energy Factor (EF) of 0.58 or higher</p> <p>If combustion equipment is selected, a low nitrogen oxide burner will be included</p> <p>Equipment will be functional at high efficiency under all load conditions</p> <p>Standby losses will be reduced to maximum potential</p> <p>Fuel type will be selected based on affordability to occupant</p> <p>Equipment will be freeze resistant or installed in a conditioned space</p> <p>Efficiency of equipment will be maintained throughout life of system</p> <p>Occupant control of hot water temperature will be provided on the equipment</p> <p>The following will be determined from the occupant:</p> <ul style="list-style-type: none"> • Lifestyle • Current and future needs • Space considerations • Fuel options • Health and safety considerations • Appliance options • Maintenance and operation costs • Return on investment concerns 	<p>Save energy and water</p> <p>Protect the environment</p> <p>Identify appliance options based on the needs and wants of the occupant</p>

Title	Specification(s)	Objective(s)
7.8102.1b Product selection	<p>Water heater will be selected based on performance requirements of the occupant, available fuel sources, energy efficiency, and total life cycle cost</p> <p>In very cold climates, on-demand water heaters will be sized to meet the demand of water flow at very low water intake temperatures</p> <p>When evaluating an existing thermal solar water heating system, a solar expert should be consulted</p> <p>The proper installation and maintenance of solar hot water systems is provided in the Uniform Solar Energy Code (USEC) and 2012 IRC Chapter 23</p>	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

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

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

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

Title	Specification(s)	Objective(s)
7.8102.2a Hazardous material removal	<p>Health concerns in the removal and replacement of equipment (e.g., asbestos, other hazardous materials) will be identified</p> <p>Written notification will be provided to occupants of the discovery of hazardous material, including contact information for regional EPA asbestos coordinator</p> <p>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)</p>	Remediate health hazards using EPA -certified contractors
PA WAP Guidance:	Refer to PA WAP Health and Safety Plan if lead and/or asbestos is suspected.	

Title	Specification(s)	Objective(s)
7.8102.2b Equipment removal	<p>Accepted industry procedures and practices will be followed to:</p> <ul style="list-style-type: none"> 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 <p>All work shall be completed by a licensed plumbing professional where required by the authority having jurisdiction and installed to industry-accepted standards</p>	<p>Ensure the safety of the workers and occupants</p> <p>Preserve integrity of the building</p> <p>Remove old equipment in a timely and efficient manner</p>
7.8102.2c New equipment installation	<p>New water heater and associated components will be installed to accepted industry standards, in accordance with the 2012 IRC and manufacturer specifications</p> <p>The system will be installed to be freeze resistant</p> <p>Any existing water leaks will be repaired before installation begins</p> <p>Any penetrations to the exterior of the home created by the installation of the equipment will be sealed</p>	<p>Ensure the safety of the workers and occupants</p> <p>Preserve integrity of the building</p> <p>Remove old equipment in a timely and efficient manner</p>
7.8102.2d Emergency drain pan	<p>An emergency drain pan will be installed with sides that extend a minimum of 4" above floor if leakage would cause damage to the home and in accordance with P2801.5 of the 2012 IRC</p> <p>A ¾" drainline or larger will be connected to tapping on pan and terminated in accordance with P2801.5.2 of the 2012 IRC</p>	<p>Collect and safely dispose of water escaping from the storage tank</p>
PA WAP Guidance:	Apply only to replacements/new installations.	
7.8102.2e Expansion tank	<p>A potable water expansion tank will be installed on the cold water side</p> <p>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</p>	<p>Protect the storage tank from expansion</p>
PA WAP Guidance:	Always install with new water heater. Apply to existing water heaters if there is evidence that an expansion tank is necessary to install for health and safety.	

Title	Specification(s)	Objective(s)
7.8102.2f Temperature and pressure relief valve	<p>Correct temperature and pressure relief valve will be installed in compliance with P2803 of the 2012 <i>IRC</i> and according to manufacturer specifications</p> <p>Temperature and pressure relief valve discharge tube will be installed in accordance with P2803.6.1 of the 2012 <i>IRC</i></p>	Discharge excessive energy (pressure or temperature) from storage tank to safe location



Before

Water heaters should be not capped off at T&P valve



After

T&P discharge should be piped to a safe and observable location

Tools:

1. Pipe wrench
2. Hacksaw

Materials:

1. PVC
2. Plumber's epoxy

Check local jurisdictional codes.

Paraphrased from 2012 IRC P2803.6.1: Temperature and pressure relief valve discharge pipes should not be connected to drainage system. T&P discharge pipes should be a clean line without valve or tee, flowing with gravity to an observable and safe location that cannot cause personal injury or structural damage -- the floor, an existing drain pan, a waste receptor, or to the outdoors. Pipe should not terminate more than 6" from floor, pan or waste receptor.



GOOD:
T&P discharge should be piped within 6" of the floor or to outdoors



BAD: T&P discharge should flow with gravity and be observable



BAD: T&P discharge should not be piped into drainage system

Title	Specification(s)	Objective(s)
7.8102.2g Dielectric unions	Dielectric unions will be installed in accordance with the 2012 <i>IRC</i> , authority having jurisdiction, and according to manufacturer specifications	Break the stray voltage electrical circuit through the storage tank
PA WAP Guidance:	Apply only to replacements/new installations.	
7.8102.2h Backflow prevention	Backflow prevention will be installed in accordance with manufacturer specifications and all applicable codes	Protect water supply from contamination
PA WAP Guidance:	Apply only to replacements/new installations.	
7.8102.2i Thermal efficiency	<p>If additional tank insulation is installed, it will be rated a minimum of R-11 and will be installed to manufacturer specifications</p> <p>If additional insulation is installed, it will be installed based on fuel type, making sure not to obstruct draft diverter, pressure relief valve, thermostats, <i>hi-limit switch</i> , plumbing pipes or elements, and thermostat access plates</p> <p>The first 6' of inlet and outlet piping will be insulated in accordance with manufacturer specifications</p> <p>Pipe insulation must remain 3" from gas water heater vent</p> <p>Heat traps will be installed on the inlet and outlet piping where not provided by manufacturer</p>	<p>Reduce <i>standby loss</i> from near tank piping and storage tank</p> <p>Ensure insulation does not make contact with flue gas venting</p>
7.8102.2j Fuel supply	Electric or fossil fuel supply components will be installed to accepted industry standards as per <i>NFPA</i> 31 and 54, or <i>NFPA</i> 70 National Electric Code (<i>NEC</i>) for electric components, or authority having jurisdiction	Provide sufficient fuel to the water heater, burner, or element

Title	Specification(s)	Objective(s)
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
PA WAP Guidance:	Provide client education on discharge temperature.	



Unsafe

Water heaters producing water over 120 degrees raise heating costs



Safe

Water heaters should produce water under 120 degrees to prevent scalding

Tools:

1. Thermometer



1. Test temperature of hot water faucets in house



2. Hot water temperatures should not exceed 120 degrees Fahrenheit



3. Adjust water heater settings and insulate as needed



4. After adjustment and insulation, retest to verify temp is under 120 degrees F

Title	Specification(s)	Objective(s)
7.8102.2l Commissioning of system	<p>The following will be checked once the system has been filled and purged:</p> <ul style="list-style-type: none"> • Safety controls • Combustion safety and efficiency • Operational controls • Fuel and water leaks • Local code requirements <p>Commissioning will be in compliance with manufacturer specifications and relevant industry standards</p>	<p>Ensure safe system function</p> <p>Keep cost of ownership as low as possible</p>
7.8102.2m Occupant safety	<p>Carbon monoxide (CO) alarms will be installed in each dwelling in accordance with ASHRAE 62.2 and authority having local jurisdiction</p> <p>Occupant will be provided information regarding the health effects and risk of high CO concentrations as well as a list of monitors that can provide more detail regarding CO levels</p>	<p>Ensure occupant life safety; CO alarms are designed to detect levels at which occupants might become unable to evacuate</p>
7.8102.2n Occupant education	<p>Completed work will be reviewed</p> <p>Occupants will be educated on the safe and efficient operation and maintenance of the system, including:</p> <ul style="list-style-type: none"> • 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 	<p>Ensure occupant is informed of the safe, efficient operation and maintenance of the system</p>

7.8102.3 On-Demand Appliance

Topic: Water Heating

Subtopic: Installation and Replacement

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

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

For supporting material, see [Calculation of the Infiltration Credit](#) and [Referenced Standards](#).

Title	Specification(s)	Objective(s)
7.8102.3a Hazardous material removal	<p>Health concerns in the removal and replacement of equipment (e.g., asbestos, other hazardous materials) will be identified</p> <p>Written notification will be provided to occupants of the discovery of hazardous material, including contact information for regional EPA asbestos coordinator</p> <p>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)</p>	Remediate health hazards using EPA - certified contractors
PA WAP Guidance:	Refer to PA WAP Health and Safety Plan if lead and/or asbestos is suspected.	
7.8102.3b Equipment removal	<p>Accepted industry procedures and practices will be followed to:</p> <ul style="list-style-type: none">• 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 <p>All work shall be completed by a licensed plumbing professional where required by the authority having jurisdiction and installed to industry-accepted standards</p>	<p>Ensure the safety of the workers and occupants</p> <p>Preserve integrity of the building</p> <p>Remove old equipment in a timely and efficient manner</p>

Title	Specification(s)	Objective(s)
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 <i>IRC</i> , authority having jurisdiction and manufacturer specifications	<p>Ensure the safety of the workers and occupants</p> <p>Preserve integrity of the building</p> <p>Remove old equipment in a timely and efficient manner</p>
7.8102.3d Emergency drain pan	<p>An emergency drain pan will be installed with sides that extend a minimum of 4" above floor if leakage would cause damage to the home and in accordance with P2801.5 of the 2012 <i>IRC</i></p> <p>A ¾" drainline or larger will be connected to tapping on pan and terminated in accordance with P2801.5.2 of the 2012 <i>IRC</i></p>	Collect and safely dispose of water escaping from the storage tank
PA WAP Guidance:	Apply only to replacements/new installations.	
7.8102.3e Temperature and pressure relief valve	<p>Correct temperature and pressure relief valve will be installed in compliance with P2803 of the 2012 <i>IRC</i> and according to manufacturer specifications</p> <p>Temperature and pressure relief valve discharge tube will be installed in accordance with P2803.6.1 of the 2012 <i>IRC</i></p>	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 <i>IRC</i> and according to manufacturer specifications	Break the stray voltage electrical circuit through the storage tank
PA WAP Guidance:	Apply only to replacements/new installations.	
7.8102.3g Backflow prevention and pressure regulator	<p>Backflow prevention will be installed in accordance with manufacturer specifications</p> <p>House water pressure and volume will be verified as sufficient to be in accordance with manufacturer specifications</p> <p>All applicable codes will be followed</p>	<p>Protect the water supply from contamination</p> <p>Provide for sufficient volume and pressure</p>
PA WAP Guidance:	Apply only to replacements/new installations.	

Title	Specification(s)	Objective(s)
7.8102.3h Thermal efficiency	Any accessible hot water lines at the appliance will be insulated to meet 2012 <i>IRC</i> N1103.4.2 or local requirements, whichever is greater.	Reduce line losses
7.8102.3i Required combustion air	Electric or fossil fuel supply components will be installed to accepted industry standards as per Chapter 24 of the 2012 <i>IRC</i> , NFGC and <i>NFPA</i> 31 and 54 for gas and oil, or <i>NEC</i> for electric Energy input required by the appliance will be in accordance with manufacturer specifications All on-demand appliances will be installed per manufacturer recommendations/specifications	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 <i>IRC</i> , 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 <i>BPI</i> -1100-T-2012 If combustion is not in compliance with <i>BPI</i> -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 <i>IRC</i> , NFGC and <i>NFPA</i> 31 and 54 for gas and oil, or <i>NEC</i> 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

Title	Specification(s)	Objective(s)
7.8102.3o Commissioning of system	<p>The following will be checked once the system has been connected and filled:</p> <ul style="list-style-type: none"> • Safety controls • Combustion safety and efficiency • Operational controls • Fuel and water leaks • Cycle unit • Local code requirements <p>Manufacturer specifications and all relevant industry standards will be met in commissioning</p>	<p>Ensure system functions safely with lowest possible cost of ownership</p>
7.8102.3p Ambient carbon monoxide (CO)	<p>All homes will have a CO alarm</p>	<p>Ensure occupant health and safety</p>
7.8102.3q Occupant education	<p>Completed work will be reviewed</p> <p>Occupants will be educated on the safe and efficient operation and maintenance of the system, including:</p> <ul style="list-style-type: none"> • 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 	<p>Ensure occupant is informed of the safe, efficient operation and maintenance of the system</p>

Subtopic 7.8103 Maintenance/Inspection

7.8103.1 Storage-Type Appliance

Topic: Water Heating

Subtopic: Maintenance/Inspection

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

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

For supporting material, see [Calculation of the Infiltration Credit](#) and [Referenced Standards](#).

Title	Specification(s)	Objective(s)
7.8103.1a Health and safety	Combustion safety testing will be performed in accordance with the Health and Safety Chapter of the Standard Work Specifications for Single Family Housing or other equivalent practice Electrical components will be verified to comply with <i>NEC</i> (e.g., no electrical box connector, no disconnect, improperly sized breaker and wire)	Identify potential health and safety issues



Before

Complete combustion safety testing to ensure healthy, safe work environment

Tools:

1. Personal CO monitor
2. Combustion analyzer with probe
3. Manometer
4. Smoke pencil



After

When completed work, retest to verify home is still healthy and safe

Materials:

1. CO alarm
2. Fasteners

See also SWS 2.0201.1a-2.0299.1i for all Combustion Safety details and SWS 2.0100.1d for General Electrical Safety.

Title	Specification(s)	Objective(s)
7.8103.1b Visual inspection	<p>Inspection will be conducted to show compliance with the 2012 <i>IRC</i> , including but not limited to:</p> <ul style="list-style-type: none"> • Water or fuel leaks • Damaged wiring • Venting issues with draft and condensation (e.g., soot, rusting of flue pipe, burned paint or wires, <i>efflorescence</i>) • Corrosion (e.g., rust, mineral deposits) • General condition of components 	Determine needed repairs or maintenance
7.8103.1c Thermal efficiency	<p>Water heater storage tanks shall have a minimum R-value of R-24, unless the SIR to add insulation is less than 1.0</p> <p>Added insulation will not obstruct the unit's draft diverter, pressure relief valve, thermostats, <i>hi-limit switch</i> , plumbing pipes or elements, and thermostat access plates</p> <p>The first 6' of inlet and outlet piping will be insulated in accordance with 2012 <i>IRC</i> N1103.4.2 or local requirements, whichever is greater</p>	<p>Reduce standby losses from near tank piping and storage tank</p> <p>Ensure insulation does not make contact with flue gas venting</p>
PA WAP Guidance:	Insulate all hot water lines that are accessible, as long as it meets an SIR of 1 or greater in the standardized audit.	



Standard water heaters have built-in insulation ranging from R-7 to R-20

Tools:

1. Utility knife



Best Practice

Storage-type water heaters should be wrapped to bring total value to R-24

Materials:

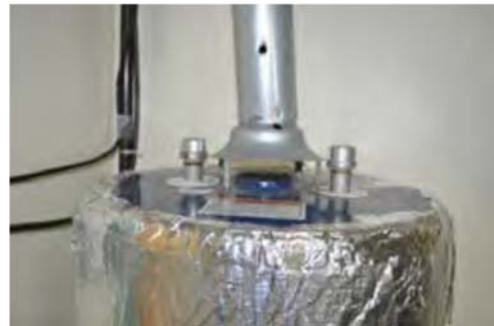
1. Pipe wrap
2. Water heater blanket
3. Foil tape
4. Long zip ties

Title	Specification(s)	Objective(s)
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7.8103.1c Thermal efficiency



1. Check occupant's water heater model to see what r-value is built-in



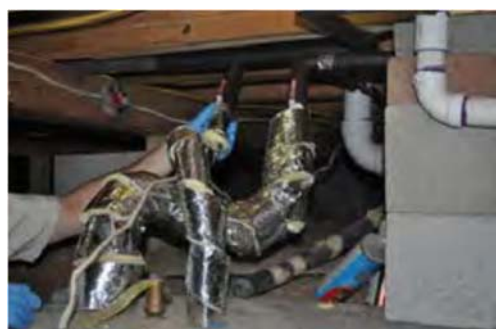
2. Blanket does not obstruct draft diverter or plumbing pipes and elements



3. Wrap does not obstruct ventilation, thermostat access plate, hi-limit switch, or fuel line



4. Data plate should still be accessible after wrapping



5. Both hot and cold water pipes should be insulated to R-3 for first 6ft

Title	Specification(s)	Objective(s)
7.8103.1d Potable water expansion tank	<p>A potable water expansion tank will be installed on the cold water side</p> <p>Tanks that leak or have excessive corrosion will be replaced</p> <p>A direct connection with no valves from the expansion tank to the storage tank will be installed</p> <p>Connection will be properly supported with strapping</p> <p>An expansion tank drain will be included in non-bladder tanks</p> <p>Tank will be installed to accepted industry standards, in accordance with the 2012 <i>IRC</i> and according to manufacturer specifications</p> <p>Tanks that are completely full of water will be drained and refilled before being replaced or repaired</p> <p>Expansion tanks with bladders will have air charged to the manufacturer pressure requirements while water is not present in the tank</p> <p>Bladder tanks with water inside of the air bladder will be replaced in accordance with manufacturer specifications</p>	<p>Absorb water expansion of the system</p>
PA WAP Guidance:	Always install with new water heater. Apply to existing water heaters if there is evidence that an expansion tank is necessary to install for health and safety.	

Title	Specification(s)	Objective(s)
7.8103.1e Temperature and pressure relief valve	<p>Correct temperature and pressure relief valve will be installed in compliance with P2803 of the 2012 <i>IRC</i> and according to manufacturer specifications</p> <p>Temperature and pressure relief valve discharge tube will be installed in accordance with P2803.6.1 of the 2012 <i>IRC</i></p>	Discharge excessive energy (pressure or temperature) from storage tank to safe location



Before

Water heaters should be not capped off at T&P valve



After

T&P discharge should be piped to a safe and observable location

Tools:

1. Pipe wrench
2. Hacksaw

Materials:

1. PVC
2. Plumber's epoxy

Check local jurisdictional codes.

Paraphrased from 2012 IRC P2803.6.1: Temperature and pressure relief valve discharge pipes should not be connected to drainage system. T&P discharge pipes should be a clean line without valve or tee, flowing with gravity to an observable and safe location that cannot cause personal injury or structural damage -- the floor, an existing drain pan, a waste receptor, or to the outdoors. Pipe should not terminate more than 6" from floor, pan or waste receptor.



GOOD:
T&P discharge should be piped within 6" of the floor or to outdoors



BAD: T&P discharge should flow with gravity and be observable



BAD: T&P discharge should not be piped into drainage system

Title	Specification(s)	Objective(s)
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: <ul style="list-style-type: none"> • 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

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

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

For supporting material, see [Referenced Standards](#) and [Calculation of the Infiltration Credit](#).

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

Title	Specification(s)	Objective(s)
7.8103.2b Visual inspection	<p>Inspection will be conducted to show compliance with the 2012 <i>IRC</i> , including but not limited to:</p> <ul style="list-style-type: none"> • 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, <i>efflorescence</i>) • Corrosion (e.g., rust, mineral deposits) • General condition of components 	Determine needed repairs or maintenance
7.8103.2c Temperature and pressure relief valve	<p>Correct temperature and pressure relief valve will be installed in compliance with P2803 of the 2012 <i>IRC</i> and according to manufacturer specifications</p> <p>Temperature and pressure relief valve discharge tube will be installed in accordance with P2803.6.1 of the 2012 <i>IRC</i></p>	Discharge excessive energy (pressure or temperature) from storage tank to safe location
7.8103.2d Flue gas testing	<p>Undiluted flue gases will be checked with a calibrated combustion analyzer in accordance with <i>BPI</i> -1100-T-2012</p> <p>If combustion is not in compliance with <i>BPI</i> -1100-T-2012, diagnostics and adjustments will be done to manufacturer specifications or local codes</p>	Perform combustion testing
7.8103.2e Required combustion air	<p>If sealed combustion has not been installed:</p> <p>Combustion and ventilation (excess air) requirements of gas-fired appliances, including provision of outside and inside air to account for building tightness, will be provided</p> <p>The minimum required volume will be 50 cubic feet per 1,000 <i>Btu</i> /h in accordance with 2012 <i>IRC</i> G2407.5.1</p> <p>If needed, additional combustion air will be provided in accordance with 2012 <i>IRC</i> G2407</p>	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 <i>IFGC</i> for gas water heaters or <i>NFPA</i> 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 <i>NFPA</i> 31 for oil, <i>NFPA</i> 54 for gas, <i>NFPA</i> 58 for propane, or <i>NFPA</i> 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

Title	Specification(s)	Objective(s)
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	<p>The following will be tested:</p> <ul style="list-style-type: none"> • 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 <p>Manufacturer specifications and all relevant industry standards will be met</p>	Ensure system functions safely with lowest possible cost of ownership
7.8103.2k Maintenance records	<p>Occupants will be advised to keep records of all maintenance done to their system</p> <p>Copies of or access to installation and operation manuals will be provided</p>	Improve chance of successful future maintenance or repair
7.8103.2l Occupant health and safety	All homes will have a carbon monoxide (CO) alarm	Ensure occupant health and safety
7.8103.2m Occupant education	<p>Completed work will be reviewed</p> <p>Occupants will be educated on the safe and efficient operation and maintenance of the system, including:</p> <ul style="list-style-type: none"> • 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

Appendix A:

ANSI-BPI-1100-T-2014 Home Energy Auditing Standard

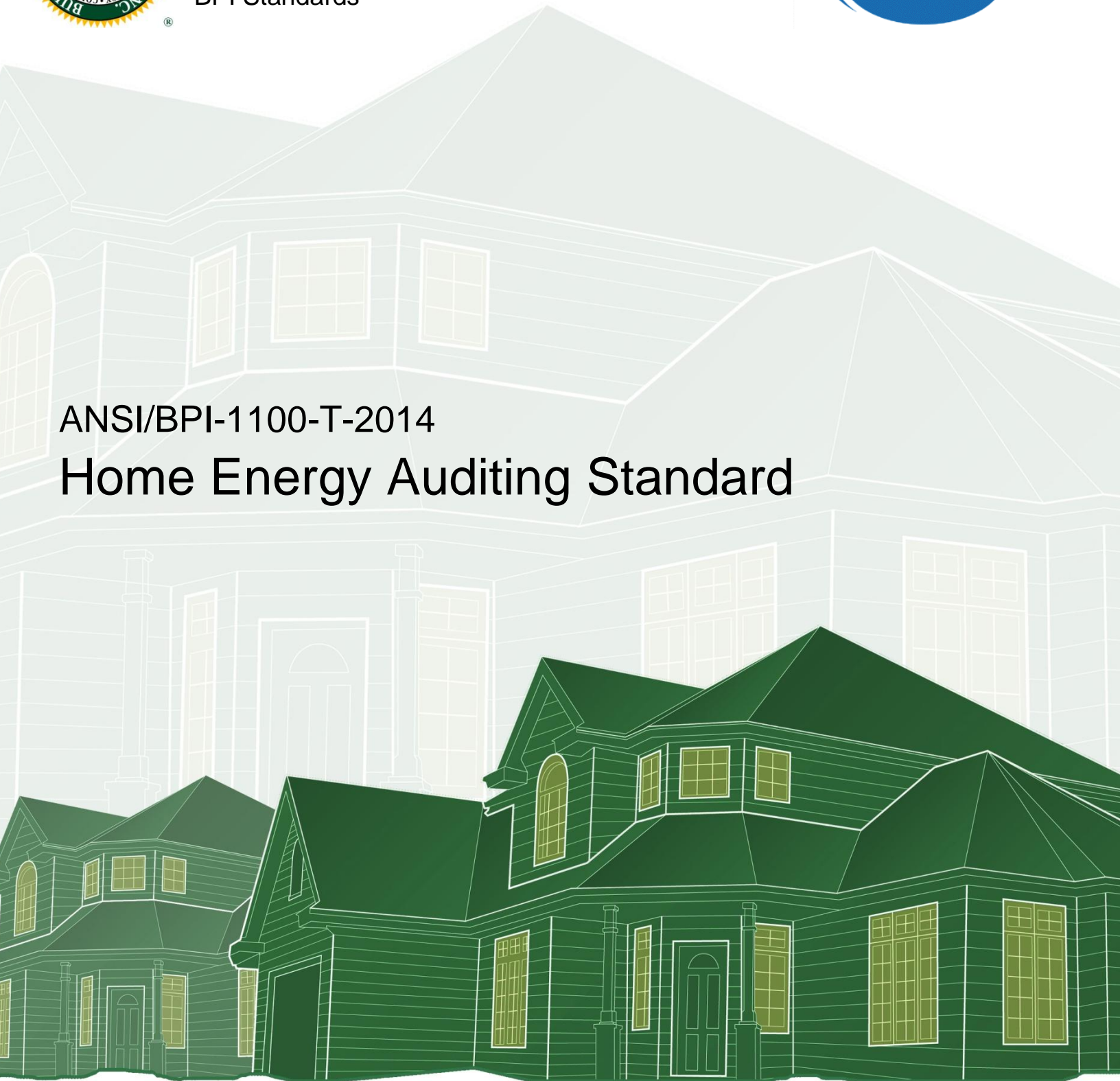
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Building Performance Institute, Inc.
BPI Standards



ANSI/BPI-1100-T-2014 Home Energy Auditing Standard



December 22, 2014

Notice

BPI standards, bulletins and other technical publications are designed to serve the public interest through eliminating misunderstandings between manufacturers, service providers and purchasers, facilitating interchangeability and improvement of products and services, and assisting the purchaser in selecting and obtaining the proper product or service for his or her particular need.

Existence of such standards, bulletins and other technical publications shall not in any respect preclude any entity affiliated with BPI (or not) from manufacturing or selling products or services not conforming to such standards, bulletins or other technical publications, nor shall the existence of such standards, bulletins and other technical publications preclude their voluntary use by those unaffiliated with BPI Standards. Bulletins and other technical publications are adopted by BPI in accordance with the American National Standards Institute (ANSI) patent policy. By such action, BPI does not assume any liability to any patent owner, nor does it assume any obligation whatever to parties adopting the standard, bulletin or other technical publication.

This standard does not purport to address all safety problems associated with its use or all applicable regulatory requirements. It is the responsibility of the user of this standard to establish appropriate safety and health practices and to determine the applicability of regulatory limitations before its use.

This standard was formulated under the cognizance of the BPI Standards Technical Committee.

Introduction (Informative)

The Building Performance Institute, Inc. (BPI) publishes standards related to the energy efficiency and performance of residential buildings. This *Home Energy Auditing Standard* is the basis for BPI's Energy Auditor Certification and provides requirements for the energy-auditing profession. The goal of this standard is to direct the energy auditor to develop a comprehensive list of measures which lead to whole-house, building science-based home performance upgrades to existing detached single-family dwellings and townhouses.

This standard is intended and structured to be used in conjunction with ANSI BSR/BPI-1200-S-201X Standard Practice for Basic Analysis of Buildings, which outlines in detail how an energy auditor shall meet the requirements noted in this standard. However, the requirements included in BPI-1100 may also be met using procedures from other American National Standards related to residential building performance. It is understood that other standards or guidelines may be required by the Authority Having Jurisdiction (AHJ) and in such instances the energy auditor should comply with the AHJ's requirements.

This *Home Energy Auditing Standard* may be used in conjunction with the U.S. Department of Energy's Home Energy Score. An assessment performed in accordance with the *Home Energy Auditing Standard* will gather all necessary data required by a Home Energy Score Qualified Assessor to develop a Home Energy Score, complete the Appraisal Institute Green Addendum, and provide energy efficiency information into the Real Estate Transaction System for inclusion in the Multiple Listing Service. Home Energy Score is the only federal asset score designed for existing homes, used nationwide and backed by DOE.

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1 Scope

This standard practice defines the minimum criteria for conducting a building science-based residential energy audit.

The energy audit will address energy usage and limited aspects of building durability and occupant health and safety. The energy audit will provide a comprehensive report with a list of prioritized recommendations to improve the home and will include a cost-benefit analysis.

Residential building types covered are defined as: existing detached single-family dwellings and townhouses that:

- have independent mechanical systems for each dwelling unit (heating, cooling, water heating, and ventilation)
- have direct access to outdoors for each dwelling unit
- were designed to have continuous party walls with no penetrations to adjacent units, with such party walls extending from ground to roof where the dwelling unit is attached to one or more adjacent single-family dwelling units.

2 General Requirements

Energy audits shall be based on building science principles and include the use of appropriate equipment in diagnosing opportunities for improving energy efficiency and minimizing health and safety hazards.

2.1 All energy audits shall include the following:

- 2.1.1 A review with the homeowner/occupant(s), if available, about any concerns they may have related to the performance of their home.
- 2.1.2 Immediate disclosure to homeowner/occupant(s) when any suspected emergency or urgent health and safety hazard or situation is present in the home.
- 2.1.3 A report that meets the requirements laid out in this standard.

2.2 All energy audit reports shall include the following:

- 2.2.1 Results of diagnostic tests and visual/sensory inspections including a summary of the diagnostic testing and inspections and their purpose.
- 2.2.2 Information on energy programs, incentives, regulations and energy costs relevant to prioritized recommendations for improving the home.
- 2.2.3 A baseline energy use analysis [when energy-consumption records are available].
- 2.2.4 A comprehensive set of recommended health and safety measures, warranted by the site-specific circumstances.

2.2.5 A comprehensive set of recommended energy efficiency measures, warranted by the site-specific circumstances.

2.2.6 Advice to the homeowner/occupants on user-controlled energy reduction strategies.

3 Health and Safety Related Requirements

The health and safety requirements included in this standard are intended to ensure that home performance upgrade activities do not negatively affect indoor air quality or otherwise cause or exacerbate an unsafe condition in the home.

The energy audit shall include the following:

- 3.1 Evaluation of combustion air requirements and a test of combustion appliances in accordance with Section 7 of this standard.
- 3.2 Evaluation of ventilation needs in accordance with Section 8 of this standard.
- 3.3 Identification of existing and/or potential moisture issues in accordance with Section 9 of this standard.
- 3.4 Identification of areas containing known or suspected hazardous materials, including but not limited to, lead, asbestos, or mold.
- 3.5 Visual inspection for existence of an Environmental Protection Agency (EPA) guidelines-compliant radon mitigation system.
- 3.6 Visual inspection for existence of knob and tube wiring.
- 3.7 Identification of obvious electrical hazards.

4 Disclosure and Ethics

The energy auditor shall act in a professional and ethical manner during the course of conducting all energy audits, completing energy audit reports, and interacting with the homeowner/occupants. (See Annex B, Code of Ethics for the Energy Auditor for guidance.)

The energy audit report shall include the following:

- 4.1 Clear and accurate information on home performance upgrades and health and safety improvements.
- 4.2 The cost-effectiveness of the recommended home performance upgrades, based on energy modeling, utility-bill history or typical usage and energy cost for similar homes in the area.
- 4.3 Disclosure of any current or potential conflict of interest of the auditor.
- 4.4 Disclosure of any products and services that the auditor or his/her company provides in addition to energy auditing.

Note: The energy audit report shall not include recommendations for measures based primarily on a specific product line, services of a contractor, or convenience.

5 Cost-Benefit Analysis

A cost-benefit analysis includes a projected site energy savings associated with the recommended home performance upgrade package(s). This may be presented in terms of reduced fuel consumption, reduced costs, a fractional performance improvement over existing performance, or an improvement on a relative scale or benchmark such as a Home Energy Score, Home Energy Rating, or Energy Performance Score. (Note: Energy simulation software is an option, but not a requirement.) Savings estimates shall clearly indicate whether savings are projected for baseload, heating, cooling, or total household energy consumption.

- 5.1 The energy audit shall include a customized cost-benefit analysis of a comprehensive package of home performance upgrades.
- 5.2 The energy audit shall include an analysis of energy consumption records to validate estimates of energy savings from the installed home performance upgrades [when energy-consumption records are available].

6 Prioritizing Recommendations

The objective of the prioritized recommendations is to optimize home performance cost-effectively, while maintaining or improving health and safety and satisfying homeowner/occupant objectives.

- 6.1 The energy audit shall include an interview with the homeowner/occupants to understand their goals, priorities, and any potential limitations or barriers for implementing home performance upgrades.
- 6.2 The energy audit report shall include the following:
 - 6.2.1 A list of applicable health and safety improvements.
 - 6.2.2 A list of home performance upgrades, building repairs and renovation work based on an evaluation of the whole house according to the requirements of this standard and prioritized according to homeowner/occupant objectives and cost-effectiveness.

7 Combustion Appliance and Fuel Distribution System Inspection

The energy audit shall include inspection of combustion appliances and fuel distribution systems for safety.

The energy audit shall include the following:

- 7.1 Identification of building-related conditions that may require immediate health and safety remediation.
- 7.2 Inspection of the ambient air for carbon monoxide (CO) and combustible gas prior to undertaking inspections of fuel distribution systems and combustion appliances.
- 7.3 Testing for gas leakage at connections of natural gas and propane piping systems.
- 7.4 Inspection of oil-fired appliance fuel supply system (tank, supply line, burner) for leaks.
- 7.5 Inspection of combustion venting systems for damage, leaks, disconnections, inadequate slope and other safety hazards.

- 7.6 Verification that sufficient combustion air is available.
- 7.7 With the combustion appliance zone (CAZ) in a depressurized state, CO tests and spillage assessment on all combustion appliances venting into atmospheric chimneys or flues, including fan-assisted gas appliances.
- 7.8 If the outlet of the exhaust is safely accessible, a CO test on all direct vent and power-vented appliances (without atmospheric chimneys or flues).
- 7.9 Testing of gas ovens and unvented appliances for CO.
- 7.10 Inspection of solid fuel burning appliances for safe operation.

8 Indoor Air Quality and Ventilation

The energy audit shall include inspection of air infiltration sources, air barriers and ventilation. Consider the house ventilation as a system, including both whole-building ventilation and local exhaust ventilation.

The energy audit shall include the following:

- 8.1 Identification of sources of indoor air pollutants.
- 8.2 For houses with an attached or “tuck under” garage, identification of joints, seams, penetrations, openings between door assemblies and their respective jambs and framing, and other sources of air leakage through walls and ceilings separating the garage from the residence and its attic area.
- 8.3 Evaluation of terminations of all exhaust fans and clothes dryer vents.
- 8.4 Evaluation of existing ventilation systems in the dwelling.
- 8.5 Determination of the ventilation needs.

9 Moisture Control

The energy audit shall include a visual/sensory inspection of each home for moisture issues.

The energy audit shall include the following:

- 9.1 Inspection for evidence of exterior water intrusion, such as roof leaks, foundation leaks, fenestration assembly leaks and ground-water intrusion.
- 9.2 Inspection for evidence of damage caused by interior water sources, such as plumbing leaks or condensation on piping, ductwork or interior surfaces.
- 9.3 Inspection for effects of water damage on buildings, such as structural damage, mold, mildew, efflorescence, and stains.
- 9.4 Identification of existing vapor retarders, flashing, gutters or other moisture-control strategies.

10 Building Enclosure

The energy audit shall include an evaluation of the performance of the building enclosure, to include both the pressure and thermal boundaries and their combined effectiveness and alignment.

The energy audit shall include the following:

- 10.1 Evaluation of the envelope insulation level and performance.
- 10.2 Evaluation of the air-leakage of the building, as determined by blower door diagnostic testing.
- 10.3 Evaluation of fenestration performance and fit.
- 10.4 Evaluation of the potential for energy savings of shading and solar-reflectance upgrades for the roof and/or wall.

11 Heating, Cooling, and Domestic Water Heating Systems

The energy audit shall include an evaluation of the heating, cooling, and domestic water heating systems in the home.

The energy audit shall include the following:

- 11.1 Evaluation of heating appliance/s operation, condition, and efficiency.
- 11.2 Evaluation of cooling appliance/s operation, condition, and efficiency.
- 11.3 Evaluation of heating and cooling distribution system/s operation, condition, and efficiency.
- 11.4 Evaluation of domestic water heating appliance/s operation, condition, and efficiency.
- 11.5 Evaluation of domestic water heating distribution system/s operation, condition, and efficiency.

12 Baseload Energy Efficiency

The energy audit shall include an estimate of present baseload energy use and cost and a description of the current major appliances and plug loads.

The energy audit shall include the following:

- 12.1 Evaluation of refrigerator and freezer energy consumption.
- 12.2 Evaluation of lighting efficiency, controls and efficient alternatives.
- 12.3 Inspection of clothes dryer vents for restrictions, lint build-up appropriate venting configuration and materials.
- 12.4 Evaluation of pool and spa energy consumption and conservation strategies.
- 12.5 Evaluation of the efficiency of other major baseload energy-consuming devices.
- 12.6 Collection of information regarding the type and input rate of installed renewable energy systems or other on-site electricity generation.
- 12.7 Advice to the homeowner/occupant about user-controlled changes that may reduce energy consumption including:
 - 12.7.1 Plug loads and associated electricity costs.
 - 12.7.2 Calculated baseload energy consumption with space conditioning energy usage disaggregated from baseload energy usage [when energy-consumption records are available].

12.7.3 A comparison of the home's energy use with similar homes in the region [when data is available].

12.7.4 Value of energy saving behaviors and measures.

13 Water Conservation


The energy audit shall include an assessment of potential water conservation measures.

The energy audit shall include the following:

13.1 Evaluation of water usage of toilets, shower heads, faucets, and clothes washers.

13.2 Advice to the homeowner/occupant about the value of water efficiency and conservation strategies and user-controlled changes that may reduce water consumption.

Annex A | Terms and Definitions (Normative)

Term	Definition
Authority Having Jurisdiction (AHJ)	<p>The Authority Having Jurisdiction [AHJ] is the organization, office, or individual with final and ultimate authority for approving equipment, materials, an installation, or a procedure, where jurisdiction includes the governmental or administrative territory within which authority may be exercised, and also the scope of what trades, professions, devices or systems they regulate.</p> <p>Where public safety is the primary concern, the AHJ may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. Within federal, state, local, or other regional programs, the program administrator, utility commission, or others having regulatory authority or responsibility for the program may be the AHJ.</p> <p>In many cases, there may be more than one organization, agency, or department that has “jurisdiction” over particular work, but regulations and statutes establish and define relationships and levels of authority, so that only one entity has “authority.” A good example of this overlap is the one between an energy program funding source and code officials. If the project in question is a solar/PV project operating under program rules but also subject to State electrical codes, the funding source can require construction practices only to the extent that the required work does not violate the applicable electrical code, and so the code inspection office (or official) empowered under the state electrical code is the Authority Having Jurisdiction. If there is also a county or city electrical inspection office, state law identifies the Authority Having Jurisdiction, as it defines which entity has the highest level of authority and responsibility.</p>
Building Enclosure	<p>The system or assembly of components that provides environmental separation between the conditioned space and the exterior environment.</p> <p> © Building Science Corporation. Reprinted with permission.</p>
Chimney	One or more passageways, vertical or nearly so, for conveying flue or vent gases to the outdoors.
Direct Vent Furnace	A system consisting of an appliance, combustion air, and flue gas connections between the appliance and the outdoor atmosphere, and constructed so that all air for combustion is obtained from the outdoor atmosphere and all flue gases are discharged to the outdoor atmosphere.
Fan-Assisted Combustion Appliances	An appliance equipped with an integral mechanical means to either draw or force products of combustion through the combustion chamber or heat exchanger.
Flue	A passage through which combustion gases are conveyed from the combustion chamber to the outside atmosphere.

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Annex A – Terms and Definitions

Flue Gases	Products of combustion plus excess air in appliance flues or heat exchangers. This does not include dilution air from a draft diverter.
Home	A place of residence.
Pressure Boundary	The barrier that prevents infiltration of outdoor air into the conditioned space and exfiltration of indoor air to the outside. It should be continuous and aligned with the thermal boundary. The pressure boundary is effective if it stops most air leakage
Spillage	Entry of combustion products into a building from dilution air inlets, vent connector joints, induced draft fan case opening, combustion air inlets, or other locations in the combustion or venting system of a vented combustion appliance (boiler, fireplace, furnace, or water heater), caused by backdrafting, vent blockage, or leaks in the venting system.
Thermal Boundary	The insulation boundary that separates conditioned from non-conditioned spaces in a building. It should be continuous and aligned with the pressure boundary.
Unvented Room Heater	Category of unvented, self-contained, free standing, non recessed (except as noted) fuel gas burning appliance for furnishing warm air by gravity or fan without duct connection. Gas hearth appliances listed to ANSI Standard Z21.11.2 include Gas Fireplaces and Fireplace Inserts.
Vent	A passageway used to convey flue gases from appliances or their vent connectors to the outdoors. Or: An opening that allows air, gas, or liquid to pass out of or into a confined space.
Vent Connector	The pipe or duct that connects a fuel gas-burning appliance to a vent or chimney.
Vent Gases	Products of combustion from appliance plus excess air, plus dilution air in the venting system above the draft hood or draft regulator.
Venting	The conveyance of combustion products to the outdoors.

Annex B | Code of Ethics for the Energy Auditor (Informative)

(This appendix is not part of the standard. It is informative and does not contain requirements necessary for conformance to the standard.)

The Building Performance Institute, Inc. (BPI) is committed to promoting the highest level of professionalism, integrity, and ability available in the residential contracting industry.

This Code of Ethics for Energy Auditors is designed to foster trust and mutual respect among individuals working in the industry as well as the public at large; it is intended to increase the esteem of the credentials and of the individuals who have earned them. This Code does not discourage healthy competition within the industry. BPI considers industry relationships critical to the industry's success. This Code is also not intended to limit the ability of energy auditors to earn fair compensation for their services. BPI's goal is to promote the professionalism of energy auditors' work products and thereby to enhance their quality.

I. Avoiding Conflicts of Interest

- A. Energy auditors shall not be inappropriately motivated by any financial, personal, or professional purpose other than performing residential energy audits in compliance with this standard.
- B. Energy auditors shall avoid, whenever possible, even the appearance of a conflict of interest and shall disclose all potentially questionable associations and relationships in advance to any stakeholder with a legitimate right to be informed of them.

II. Professionalism and Integrity

- A. Energy auditors shall comply with all safety-related regulations, warnings, and instructions set forth by local, state, or federal organizations and other recognized safety organizations.
- B. Energy auditors shall report any identified safety concerns to the homeowner/occupant.
- C. Energy auditors shall make recommendations based on best practices and standards in the field, using diagnostics, testing, and visual inspection within their areas of education, training, and expertise.
- D. Energy auditors shall provide professional services that effectively guide the homeowner/occupant to reduce energy consumption, improve health and safety, and increase the lifespan of the building while also improving the comfort for building occupants.
- E. Energy auditors shall help the homeowner/occupant to evaluate the costs and benefits of available energy efficiency options in a way that promotes the homeowner/occupant's best interests.

III. Representation of the Energy Auditor Profession and Self-Representation

- A. Energy auditors shall neither misrepresent nor knowingly deceive others concerning their experience and capabilities.
- B. Energy auditors shall act professionally at all times and in the best interests of the homeowner/occupant. Energy auditors shall not act in any way that denies or impedes competent, timely, and professional service to the homeowner/occupant.

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Annex B – Code of Ethics for the Energy Auditor

- C. Energy auditors shall not willfully damage, or by negligence or indifference allow to be damaged, any property belonging to the homeowner/occupants. Energy auditors shall take reasonable means to protect the homeowner/occupant's health, safety, property, and possessions and also to prevent the undue loss, theft, waste, and dissipation of the homeowner/occupant's funds, resources, and supplies.
- D. Energy auditors shall not betray the trust that homeowner/occupants have placed in them by inviting them to work in their homes.
- E. Energy auditors shall ensure that any individuals working under their supervision will act in a professional manner, in compliance with all applicable laws, regulations, and standards, and in compliance with all articles specified by this Code of Ethics.

IV. Maintaining Confidentiality

Energy auditors shall not, without permission, disclose private, confidential information about any client for the use or interests of any third parties whose services and opinions have not been explicitly requested by the homeowner/occupant. The energy auditor may discreetly discuss their own work and working conditions with their family and associates, but not in any way that violates the privacy of the homeowner/occupants.

Appendix B:

Standardized QCI Checklist for PA WAP (2-19-2016)

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Quality Control Inspection Check List

Agency Job #: _____ Agency: _____

☐ Owner ☐ Renter

Client Name: _____ Prior QCI Inspections (1) (2) (3) (n/a)

Address: _____

Quality Control Inspector: _____ QC Inspection Date: _____

QCI Contact _____ QCI Phone: _____

Agency Contact Name _____

Agency Contact Phone _____ e-mail _____

Housing Type: ☐ Single Family ☐ Pre 1976 Mobile Home ☐ Manufactured Housing ☐ Multi-family ☐ Shelter

Primary Fuel: ☐ Natural Gas ☐ Propane ☐ Electric ☐ Oil ☐ Other: _____

Secondary /Supplemental Fuel Source: ☐ Natural Gas ☐ Propane ☐ Electric ☐ Oil ☐ Other: _____

FILE REVIEW & QUALITY ASSURANCE	YES	NO	N/A	COMMENTS
1. Appropriate signatures verified?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
2. Eligibility Determination present?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
3. Ownership Verification?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
4. State Historic Preservation Documentation?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5. Whole House Audit <input type="checkbox"/> Priority List <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
6. Whole House Moisture Assessment Form?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
7. Wx Mold Assessment and Release Form?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
8. Lead-Paint Notification/EPA Lead Paint Pamphlet Sign-Off?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
9. Certified Renovator/EPA Renovation Recordkeeping Checklist Documentation?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
10. Lead Safe Photographic Documentation?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
11. Radon Information Form?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
12. Asbestos Assessment/Release Form?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
13. Work Order?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
14. Verification of Bid Amount against the Invoice.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
15. Comparison of Audit Costs Input against Invoice Actuals.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
16. Work/Service Agreement with client?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
17. Energy Education provided? If so, when?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
18. Identification of Occupant Health Conditions?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
19. Post Inspection Client Sign Off?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
20. Are job anomalies sufficiently noted?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
21. Agency identified client complaint? If so, resolved? Yes <input type="checkbox"/> No <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
22. Call back Documentation?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
23. OSHA safety standards were followed? Photos Included? Yes <input type="checkbox"/> No <input type="checkbox"/> Confined Space Documentation? Yes <input type="checkbox"/> No <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
24. One year warranty information provided?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
25. Ten year warranty option given?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

CLIENT SATISFACTION INTERVIEW BY QCI

	YES	NO	N/A
1. Were the workers polite?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Did the workers conduct themselves in a professional manner?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Did the Workers damage anything?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Did the workers clean up afterwards?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Would you recommend them to others?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Comments**ON-SITE WORK ASSESSMENT / DIAGNOSTICS****VISUAL/SENSORY INSPECTION**

	YES	NO	N/A
1. Exterior Inspection of Home Performed	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Interior Inspection of Home Performed	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Is there any damage potentially caused by workers?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**USE MANOMETER FOR ALL TESTING
INFILTRATION TESTING****Basement Door Open – Basement Included****YES** **NO** **N/A**

1. Pre & Post Blower Door Results (@CFM 50) ☐ ☐ ☐
2. Pre #: _____ cfm Post #: _____ cfm QCI #: _____ cfm

Agency ASHRAE 62.2-2013 calculation results _____**QCI ASHRAE 62.2-2013 results** _____**Basement Door Closed – Basement Not-Included****YES** **NO** **N/A**

3. Pre & Post Blower Door Results (@CFM 50) ☐ ☐ ☐
4. Pre #: _____ cfm Post #: _____ cfm QCI #: _____ cfm

Agency ASHRAE 62.2-2013 calculation results: _____**QCI ASHRAE 62.2-2013 results:** _____**Comments****Insert RED Calc Printout Here:**

INTERMEDIATE ZONAL READINGS

1. Crawlspace/Basement (WRT House)

Pre #: _____ pa Post #: _____ pa QCI #: _____ pa

2. Attic (WRT House)

Pre #: _____ pa Post #: _____ pa QCI #: _____ pa

3. Garage (WRT House)

Pre #: _____ pa Post #: _____ pa QCI #: _____ pa

DIAGNOSTIC TESTING

1. Pressure Pan Test

Pre #:	_____ pa	Post #:	_____ pa	QCI #:	_____ pa	Location:	_____
Pre #:	_____ pa	Post #:	_____ pa	QCI #:	_____ pa	Location:	_____
Pre #:	_____ pa	Post #:	_____ pa	QCI #:	_____ pa	Location:	_____
Pre #:	_____ pa	Post #:	_____ pa	QCI #:	_____ pa	Location:	_____
Pre #:	_____ pa	Post #:	_____ pa	QCI #:	_____ pa	Location:	_____
Pre #:	_____ pa	Post #:	_____ pa	QCI #:	_____ pa	Location:	_____
Pre #:	_____ pa	Post #:	_____ pa	QCI #:	_____ pa	Location:	_____
Pre #:	_____ pa	Post #:	_____ pa	QCI #:	_____ pa	Location:	_____
Pre #:	_____ pa	Post #:	_____ pa	QCI #:	_____ pa	Location:	_____
Pre #:	_____ pa	Post #:	_____ pa	QCI #:	_____ pa	Location:	_____

2. Fan Flow Test

A.	Pre #:	_____ cfm	Post #:	_____ cfm	QCI #:	_____ cfm	N/A	<input type="checkbox"/>
B.	Pre #:	_____ cfm	Post #:	_____ cfm	QCI #:	_____ cfm	N/A	<input type="checkbox"/>
C.	Pre #:	_____ cfm	Post #:	_____ cfm	QCI #:	_____ cfm	N/A	<input type="checkbox"/>

3. Duct Pressurization Test (@CFM 25)

Pre #: _____ cfm Post #: _____ cfm QCI #: _____ cfm

HEATING, VENTILATION, A/C

	YES	NO	N/A	Secondary		
	YES	NO	N/A	YES	NO	N/A
1. Combustion Appliance Safety Tests	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Heating System Replacement	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Need for furnace replacement documented?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Manual J?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Photos?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Heating System Tune-Up/Filter	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Distribution System Modifications	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. Duct Sealing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Set-Back Thermostat	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. Current ASHRAE calculations performed?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. Ambient CO Testing						

Outdoors: _____ ppm Indoors: _____ ppm CAZ: _____ ppm

DOMESTIC HOT WATER

Water Temperature (at TAP, in degrees) before Combustion Test:

Pre-work _____ ° Post-work _____ ° QCI: _____ °

COMBUSTION APPLIANCE SAFETY TEST RESULTS**DHW****Spillage:**Pre-work ☐Pass ☐Fail ☐N/A Post-work ☐Pass ☐Fail ☐N/A QCI: ☐Pass ☐Fail ☐N/A**CO:**

Pre-work _____ ppm Post-work _____ ppm QCI: _____ ppm

Efficiency:

Pre-work _____ % Post-work _____ % QCI: _____ %

Gas Leak:Pre-work ☐Yes ☐No Post-work ☐Yes ☐No QCI: ☐Yes ☐No**Flue Pitch:**Pre-work ☐Pass ☐Fail Post-work ☐Pass ☐Fail QCI: ☐Pass ☐Fail**WC CAZ:**Pre-work ☐Pass ☐Fail pa Post-work ☐Pass ☐Fail pa QCI: ☐Pass ☐Fail PaDual: ☐Yes ☐No ☐N/A**Draft:**

Pre-work _____ pa Post-work _____ pa QCI: _____ pa

Drain Pan (if required) ☐Yes ☐No**1. Furnace/Boiler *Photo Required if Replaced. Supplied?** ☐Yes ☐No**Manufacturer Model #:** _____**Manufacturer Serial #:** _____**Spillage:**Pre-work ☐Pass ☐Fail ☐N/A Post-work ☐Pass ☐Fail ☐N/A QCI: ☐Pass ☐Fail ☐N/A**CO:**

Pre-work _____ ppm Post-work _____ ppm QCI: _____ ppm

Efficiency:

Pre-work _____ % Post-work _____ % QCI: _____ %

Gas Leak:Pre-work ☐Yes ☐No Post-work ☐Yes ☐No QCI: ☐Yes ☐No**Flue Pitch:**Pre-work ☐Pass ☐Fail Post-work ☐Pass ☐Fail QCI: ☐Pass ☐Fail**Flue temp:**

Pre-work _____ ° Post-work _____ ° QCI: _____ °

Appliance area ambient temp:

Pre-work _____ ° Post-work _____ ° QCI: _____ °

WC CAZ:Pre-work ☐Pass ☐Fail pa Post-work ☐Pass ☐Fail pa QCI: ☐Pass ☐Fail PaDual: ☐Yes ☐No ☐N/A

Draft:

Pre-work _____ pa Post-work _____ pa QCI: _____ pa

Temperature Rise:

Pre-work _____ ° Post-work _____ ° QCI: _____ °

2. Stove**CO** (Dashboard required. Also, check each burner and list results in comments.):

Pre-work _____ ppm Post-work _____ ppm QCI: _____ ppm

Ambient CO:

Pre-work _____ ppm Post-work _____ ppm QCI: _____ ppm

Comments**INCLUDE PICTURES FOR WX MEASURES INSTALLED AS REQUIRED****ATTIC**

	YES	NO	N/A		Secondary Locations		
	YES	NO	N/A		YES	NO	N/A
1. Attic Insulation Installed	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Good Coverage, LIST R-value _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Good Coverage, LIST R-value: _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Insulation Certificate Completed & Posted	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Heat Source Damming	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. Exhaust Venting	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Attic Access Insulated & Secured	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. Energy Related Repairs (<i>List in Comments</i>)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. Adequate Ventilation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. Work Meets Standards (Per SWS)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11. Photos	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

SIDEWALLS & KNEEWALLS

	YES	NO	N/A		YES	NO	N/A
1. Walls Insulated by WAP	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
a) Dense-pack method	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Plugs, Patching, & Painting as appropriate	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Energy Related Repairs (<i>List in comments</i>)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Work Meets Standards (Per SWS)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Photos	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

SUBSPACE

	YES	NO	N/A		YES	NO	N/A
1. Foundation/Perimeter Insulation added	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Floor Insulation added by WAP	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Basement Wall Insulation by WAP	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Vapor Barrier added; Coverage & Secure	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Work Meets Standards (Per SWS)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. Photos	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

WINDOWS/DOORS

	YES	NO	N/A		YES	NO	N/A
1. Need for window replacement documented?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Need for door replacement documented?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Number of Windows Replaced: _____			<input type="checkbox"/>	_____			<input type="checkbox"/>
4. Proper Justification SIR >1.0 <input type="checkbox"/> Health and Safety <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Number of Storm Windows Installed: _____			<input type="checkbox"/>	_____			<input type="checkbox"/>
6. Number of Doors Replaced: _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Door Weather-stripping/Thresholds/Sweeps	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. Other: Sunscreens/Film _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. Work Meets Standards (Per SWS)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. Photos	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

OTHER MEASURES

	YES	NO	N/A
1. Water Heater Replacement	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Water Heater Treatment (Tank Wrap)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Pipe Insulation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Low Flow Showerheads	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Faucet Aerators	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. Lighting Installed #CFLs _____ #LEDs _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Refrigerator Replacement	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
a. Kouba-Cavallo Calculation _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. Smoke Detectors	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. Carbon Monoxide Detectors	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. Other H&S Measures (<i>List in Comments</i>)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11. Other Energy Related Repairs (<i>List</i>)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other Air Sealing Measures (<i>List</i>)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
12. Other (<i>Describe in comments</i>)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
13. Work Meets Standards (Per SWS)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Comments

OTHER

- | | YES | NO | N/A |
|-------------------------|--------------------------|--------------------------|--------------------------|
| 1. Audit discrepancies? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

Describe:

- | | YES | NO | N/A |
|-------------------------------------|--------------------------|--------------------------|--------------------------|
| 2. Were there missed opportunities? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

Describe:

- | | YES | NO | N/A |
|--|--------------------------|--------------------------|--------------------------|
| 3. Were other programs coordinated in job? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

Describe:

Is the Quality Control Inspection for unit complete or is further work required? ☐ Complete ☐ Incomplete
(*Add comments on additional pages if necessary)

Comments:

If no, are more in-progress inspections warranted? ☐ Yes ☐ No

Explain: Are there patterns of non-compliance, health and safety, lead-safe or OSHA concerns?

(*Add comments on additional pages if necessary)

Comments:

Also, should additional job site documents be reviewed? ☐ Yes ☐ No

Explain which documents:

Call Back Items to be addressed:

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.

Add additional pages if necessary

Recommendation for additional training of contractors/subcontractors:

Recommended Training:

Company Name: _____

Phone: _____

Recommended Course(s)/Topic(s):

Quality Control Inspector Name (Print): _____

Signature: _____ **Date:** _____

By this signature, I acknowledge that my only work in this home was the QC Inspection.

Additional Comments

Appendix C:

Calculation of the Infiltration Credit

Calculation of the Infiltration Credit

The infiltration credit that can be used to reduce the required installed fan flow requires estimating the infiltration using the blower door test result. This calculation can be reduced to a few inputs using certain assumptions. This section provides this reduced equation for the infiltration credit. For a more detailed step-by-step discussion, see the end of this page.

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

$$Q_{inf} = 0.052 \times ws \times S \times Q_{50}$$

Where:

ws = a weather factor specific to a geographic location

S = a factor accounting for the height of the house, determined from Table A-1

Q_{50} = the blower door test result in CFM50 (cubic feet per minute at 50 Pa)

Q_{inf} = infiltration in CFM

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

Stories	1	1.5	2	2.5	3
S-Factor	1.00	1.18	1.32	1.44	1.55

In ASHRAE Standard 62.2-2013, the infiltration rate Q_{inf} is the same as the infiltration credit, and can be fully subtracted from the fan flow rate.

Use of ASHRAE Standard 62.2-2013, Appendix A

ASHRAE Standard 62.2-2013 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 62.2-2013.

Per ASHRAE 62.2-2013

- Each bathroom should have a 50 CFM fan, if used on demand.
 - Note: Half baths do not require ventilation per ASHRAE Standard 62.2-2013 – only bathrooms with a shower and/or tub require local exhaust.

- Each kitchen should have a 100 CFM fan, if used on demand.

For each of these rooms that does not meet the stated local exhaust 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 (if allowed by the authority having jurisdiction). Sum up all of the individual deficits.
3. Divide by 4.
4. Add the result to the required primary continuous 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 exhausts to outside but 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.

1) Calculation of ELA

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

Where:

Q_{50} = blower door leakage at 50 Pa [ft^3/min] @ 50 Pa (or CFM50)

n = house leakage curve exponent

ΔP = reference pressure difference between inside and outside (Pa)

ρ = density

By assuming that $n = 0.65$ (experimental average value for residential houses), $\Delta P = 4$ Pa (typical reference value for ELA), and the density is a constant of (1.2 kg/m^3) , and by converting all metric units to consistent inch-pound (I-P) units, the ELA can be rewritten as:

$$ELA = 0.000381 Q_{50}$$

(with Q_{50} measured as CFM50, ELA has units of ft^2)

2) Calculation of NL

$$NL = \frac{1000 ELA}{A_{\text{floor}}} \left(\frac{H}{H_r} \right)^{0.4}$$

Where:

A_{floor} = floor area of the house (ft^2)

H = height of the house above grade (ft)

H_r = reference height of one story = 8 ft

The normalized leakage was developed assuming that the volume is 2.5 meters (8.2 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:

$$NL = \frac{3.1242 Q_{50}}{V} \left(\text{stories} \right)^{0.4}$$

Where:

V = volume of the house (ft^3)

(TECHNICAL NOTE: The height of 2.5 m (8.2 ft) was used for determining the constant in order to be consistent with ASHRAE Standard 62.2-2013 in sections that the user does not need to input information; however, a height of 8 ft was used for the story factor. An analysis of the impact of the use of 8 ft for the story factor instead of 2.5 m (8.2 ft) shows less than a 1% error, which was considered acceptable in the name of simplicity for the user.)

3) Calculation of infiltration at normal operating conditions

$$I = NL \cdot wsf$$

Where:

wsf = 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 62.2-2013.

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

$$Q_{inf} = \frac{V}{60} I$$

Where:

Q_{inf} = infiltration in CFM

60 = conversion from hours to minutes

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

$$Q_{inf} = 0.052 \cdot wsf \cdot \left(\text{stories} \right)^{0.4} \cdot Q_{50}$$

In ASHRAE Standard 62.2-2013, there is no *default* infiltration. The *measured* infiltration rate based on the blower door test can be subtracted from the fan requirement, including any adjustment for deficits, in full.

Appendix D:

PA SWS Field Manual Proposed Change Form

**Pennsylvania Weatherization Assistance Program
PA SWS Field Manual Proposed Change Form**

Submit this *Proposed Change Form* with any attachments to wxtechteam@pct.edu.

Contact Information:

Name:

Agency/Company:

Email:

Phone:

Proposed Changes:

- 1. Identify:** PA WAP Policies & Procedures, Standard Work Specifications, Best Practices, or Appendices by specific chapter, SWS number, and page number.

- 2. Photo Replacement:** Attach photo with submission and explain if it is a new photo or replacing an existing photo.

- 3. Language:** “Cut and paste” current language and use “Track Changes” (strikethrough and underline) to show proposed changes.

4. Reason for Change: Briefly explain why the change is needed.

Additional Information or Comments (use additional pages if necessary):