# Home Energy Savings Program

## California
## Technical Specifications Manual

Version 3.0
Release Date – January 1, 2016

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## Foreword from the Home Energy Savings Program

This Technical Specifications Manual articulates the Pacific Power Home Energy Savings Program requirements for HVAC, plumbing, and weatherization equipment and service measure installations. This manual is intended to ensure the safety, durability and energy efficiency of customers' homes and provide valuable technical resources for installers.

The weatherization and mechanical specifications included in this manual describe the installation requirements for measures that are eligible for cash incentives. For specific Program requirements, such as eligible measures, please refer to the appropriate Trade Ally Program Manual. The Program will conduct quality assessment reviews in accordance with applicable specifications and Program requirements.

This manual goes into effect on January 1, 2016. Please familiarize yourself with these updates and make sure you are aware of any changes relevant to your work.

For more information, please email wvn@nexant.com or call 1-855-805-7231.

Sincerely,

Pacific Power Home Energy Savings Team

# IN—INTRODUCTION

## IN 1.0—Program Goals and Eligibility

The Pacific Power Home Energy Savings Program (Program) offers cash incentives on a variety of HVAC, plumbing, and weatherization equipment and services. The Program promotes installation practices that are designed to maximize system performance and efficiency. By helping customers minimize their energy use, the Program saves customers money on their energy bill and also reduces the growing demand for power in the region.

The main purpose of weatherization installations is to prevent winter heat loss or summer heat gain from conditioned indoor spaces to unconditioned or outdoor spaces. Conditioned space is defined as an enclosed area within a building that is heated or cooled and designed, or modified, to have a complete and effective pressure boundary. Garages, barns, unattached shops, sheds, unfinished attics and crawlspaces are considered unconditioned space for the purposes of incentive qualification. A garage is defined as any space, heated or unheated, that features a large door designed to permit the entry of an automobile. Weatherization measures shall be installed in the thermal envelope—or building shell—of a home. These areas are typically defined by the separation of conditioned and unconditioned spaces, or between a conditioned space and the outside of the house. To be eligible for a Program insulation incentive, all insulation shall be in contact with a continuous and effective air barrier. Sheetrock, plywood and foam board are examples of air barrier materials; fiberglass batt-type insulation is not considered an air barrier.

Plumbing and HVAC equipment and service measures are intended to improve performance and efficiency of space and water heating and cooling equipment. All measure qualifications shall be met including compliance with qualified fuel type, floor area served by equipment, and existing equipment.

To be considered a complete measure and eligible for incentives, a measure shall meet all specifications and requirements listed in:

1. The relevant sections of this manual
2. The relevant sections of the Trade Ally Program Manual
3. The relevant incentive application form(s)
4. The relevant Trade Ally Participation Agreement(s)

Resources and additional information can be located at: homeenergysavings.net/

The Technical Specifications Manual may not cover every situation. If you have questions, email the Home Energy Solutions Trade Ally Team at wvn@nexant.com or call 1-855-805-7231.

## IN 1.1—Code Compliance, National and Regional Standards

In cases where federal, national, regional, state or local code or regulation exceeds the requirements herein, the code or regulation shall apply. If the federal, national, regional, state or local code or regulation does not exceed the requirements herein, the requirements contained in this Technical Specifications Manual shall apply. Examples of national and regional regulations include, but are not limited to, building permit, asbestos, lead, combustion appliance, vermiculite, knob and tube wiring, and fire safety requirements.

It is the contractor's sole responsibility to conform to all applicable codes and regulations for installing mechanical equipment in existing homes. Where applicable codes exceed these specifications, installation shall comply with code minimums.

Contractors bear sole responsibility for complying with all relevant state and national guidelines where the presence of regulated materials is known or suspected, in order to ensure technician and occupant safety. Where the presence of regulated materials is known or suspected, contractors are encouraged to consult guidelines from, but not limited to:

Occupational Health and Safety Division (OSHA): www.osha.gov/
Environmental Protection Agency (EPA): www.epa.gov/lawsregs/topics/
Building Performance Institute (BPI): www.bpi.org/tools_downloads.aspx?selectedTypeID=STD

## IN 1.2—Knob and Tube Wiring

Active knob and tube wiring in attics, walls or floors shall be decommissioned and removed before insulation is added. Alternatively, the electrical system shall be inspected and shall receive written approval by a certified electrical inspector or general supervising electrician employed by a licensed electrician before insulation is added. A copy of any such written approval shall be provided to the customer and, upon request, to the Program. Insulation of attics, walls or floors with knob and tube wiring shall adhere to state and local code.

Refer to WA 1.1 for additional information on insulating exterior wall cavities that contain active knob and tube wiring.

## IN 1.3—Materials

Materials used in the Program shall meet or exceed applicable state, federal or local code and regulations. All materials shall be installed to the manufacturer's specifications. The Program does not keep a list of approved products. Material information shall be provided to the Program, upon request. Adherence to applicable codes and regulations is the responsibility of the contractor or building owner. The Program reserves the right to reject the use of materials and supplies it deems unacceptable.

## IN 1.4—Foam Insulation

Foam insulation shall be installed in compliance with the manufacturer's specification and in compliance with thermal and ignition barrier requirements for foam plastics, as defined by the prevailing jurisdictional building code.

When installing foam insulation products, the manufacturer's name and product identification shall be left with the homeowner and presented to a Program representative for review, upon request, during the Quality Assurance process.

## IN 1.5—Work Quality Verification Process

After eligible measures are installed, a Quality Assurance verification may be required to ensure compliance with Program specifications. The Program will conduct Quality Assurance verifications based solely upon incentive qualifying measures. If the installed eligible measures do not meet these specifications, the Program will notify the customer and contractor of the deficiencies and follow up with the contractor to perform corrective actions. The Program does not guarantee energy savings or performance of the installations under this Program. The Program does not assume responsibility for enforcing or determining compliance with

codes and regulations or their interpretation. The Quality Assurance verification is limited to measures or sections of measures that are reasonably visible from normal access locations. A reasonable effort will be made to see a representative sample of the measure.

To ensure the work qualifies for incentives, the homeowner is responsible for discussing with the contractor any discrepancies between the work contracted and Program requirements.

## IN 1.6—Illustrations

This manual features illustrations for clarity. All illustration details are considered requirements for the weatherization measures installed.

## IN 1.7—Human Contact Areas

To receive a Program insulation incentive, fibrous insulation in human contact areas shall be covered with a vapor permeable air barrier—such as ½" gypsum board or house wrap—to limit occupant exposure. Human contact areas may include attics, basements, garages and/or storage areas where occupants go for routine maintenance, storage or access.
Vertical and overhead surfaces containing fibrous insulation and located in human contact areas shall also be covered.
All covering shall meet applicable codes.

## IN 1.8—Permits and Remodeling Projects

Incentives will not be issued for attic, wall or floor insulation improvements in existing homes if homeowners are required to make the upgrades to meet building code requirements (such as when a structural or mechanical permit is required). For example, if the exterior or interior wall sheathing is removed during a kitchen remodel project to update electrical or plumbing systems, the insulation added to repair the wall—returning it to building code requirements—is not eligible for incentives. However, the remaining walls in the home that are unaffected by the permit are eligible for standard incentives if the work meets Program requirements.

Contact the trade ally team at wvn@nexant.com or call 1-855-805-7231 for additional information regarding incentives eligibility for a remodeling project.

## IN 1.9—Equipment Maintenance

All equipment used for diagnostics, installation of insulation, safety, or other weatherization purposes shall be used in accordance with the manufacturer's instructions and shall be properly maintained and calibrated.

## IN 1.10—Combustion Safety

It is the responsibility of the Trade Ally to ensure that all combustion appliances contained within the confines of the structure are properly and safely vented, operating, and have suitable combustion air before and after duct and/or air sealing occurs and to ensure that all applicable state/local laws, codes, and standards are met and the indoor air quality of the dwelling is not compromised. A combustion appliance is any fuel-burning appliance including ovens, dryers, water heaters, and space heating systems that utilizes natural gas, propane, oil, kerosene, or wood.

A functioning and properly installed (in accordance with manufacturer's specifications) UL-listed carbon monoxide alarm is required when a combustion appliance is present within the confines of the structure when duct and/or air sealing is performed

See sections DU and AS for more information.

## IN 1.11—Determination of Existing R-Values

The total R-Value for a floor or an attic shall be calculated based on the depth of the insulation (in inches) multiplied by the recognized R-Value per inch of the insulation material.

The manufacturer-rated R-Value of an insulation batt shall be used in cases where the batts are labeled with a visibly recognizable manufacturer specification.

Refer to Appendix A for guidance in determining average R-Values for surfaces with varying levels of insulation. Refer to

Appendix B for a listing of the Program's recognized R-Values for insulation.

Willful violation of these guidelines and/or gross misrepresentation of existing insulation levels shall result in disqualification of the project in question from receiving incentives. Repeated violations may result in removal from the Trade Ally Network.

## IN 1.12—Requirements for All Mechanical System Installations

Mechanical equipment shall be installed according to the manufacturer's specifications, except in circumstances where prevailing jurisdictional codes or Program standards exceed those specifications, in which case the applicable codes or Program standards shall be followed. Mechanical equipment shall be installed as a permanent fixture on the property, including any connections to the home's electrical wiring or water piping, and including exhaust ventilation ductwork, if applicable. Mechanical equipment shall have a clearly visible, permanent, factory-affixed label identifying the serial number, make, and model number of the unit. Mechanical equipment shall in no way compromise the structural integrity of the area in which the unit is being installed.

## IN 1.13—Additional Requirements for Heating System Condensation Drains

Condensation produced by the operation of the HVAC system or heat pump water heater shall be removed from the area of installation via an adequately sloped drainage system, condensate pump or connection to an existing plumbing drain. Condensation shall slope downhill and flow to a suitable termination point. Defrost or condensate cannot run onto walkways or driveways where it may pose a safety hazard.

# PART 1: WEATHERIZATION

## AS—AIR SEALING

## AS 1.0—Introduction

Air sealing materials shall be installed according to applicable codes and shall meet the requirements of the Program. Air sealing is meant to cost-effectively increase the comfort and energy efficiency of the home without adversely affecting indoor air quality. All weatherization measures have the potential to tighten a home.

To be considered a complete measure and eligible for incentives, air sealing shall:

1. Comply with complete measure guidelines listed in section IN 1.0
2. Comply with carbon monoxide alarm guidelines listed in section AS 1.1
3. Provide homeowner Care for Your Air: A Guide to Indoor Air Quality (EPA)
4. Have a blower door test performed before and after air sealing
5. Reasonable effort shall be made to seal all accessible items in the Air Sealing Checklist below

6. Meet the applicable requirements listed in section AS
7. Meet the applicable requirements listed in section MV

Exposed soil in conditioned basements, including earth buttresses, shall be covered with a ground cover. All ground covers shall be a minimum of six-mil black polyethylene. If an existing ground cover does not meet these specifications, it shall be repaired, or a new ground cover shall be installed. All seams shall be lapped at least 12". The cover shall be continuous, with no rips, tears or gaps

Air sealing is not recommended if a visual inspection determines the home has obvious indoor air quality concerns.

## AS 1.1—Combustion Safety

Air sealing can alter the performance of combustion appliances by reducing the amount of available combustion air and can create zones of increased negative pressure. A combustion appliance is any fuel-burning appliance including ovens, dryers, water heaters, and space heating systems that utilizes natural gas, propane, oil, kerosene, or wood. Air sealing can cause increased concentrations of pollutants and humidity within the dwelling due to reduced natural air exchanges.

It is the responsibility of the Trade Ally to ensure that all combustion appliances contained within the confines of the structure are properly and safely vented, operating, and have suitable combustion air before and after air sealing occurs and to ensure that all applicable state/local laws, codes, and standards are met and the indoor air quality of the dwelling is not compromised.

Homes with unvented combustion heating appliances are not eligible for air sealing incentives.

A functioning and properly installed (in accordance with manufacturer's specifications) UL-listed carbon monoxide alarm is required when a combustion appliance is present within the confines of the structure when air sealing is performed.
Homeowners shall be made aware of the alarm and instructed how to operate, test, and maintain the alarm.

A combustion appliance zone (CAZ) is an enclosed area containing a combustion appliance for the purpose of space heating or water heating.

The Program recommends following CAZ testing procedures and requirements outlined by industry recognized organizations including, but not limited to, Building Performance Institute, RESNET, or ACCA.

## AS 1.2—Measurement

An air leakage test using diagnostic equipment to depressurize the conditioned space of the home shall be performed prior to work, and again after work is complete, to be eligible for air sealing incentives. Testing shall be performed only by technicians certified by the Building Performance Institute (BPI).

Blower door testing shall be conducted according to processes outlined by The Energy Conservatory™ or Retrotec™ and tested at 50 Pascals.

Pressure differential readings will generally be used to detect substantial leakage paths and to determine the ratio of pressure differences across interior and exterior surfaces of a zone. If non-rigid asbestos is present or suspected in the home, no blower door test will be conducted.

Basements that contain HVAC ducts or have direct access to the interior conditioned space of a home shall be considered conditioned space and shall be considered in volume calculations.

An air leakage test shall be performed before air sealing (pre-test) and after air sealing (post-test). Reductions in leakage shall be measured as follows:

$$\text{Percent Reduction} = (1 - (\text{Post-test } CFM_{50} \div \text{Pre-test } CFM_{50})) \times 100$$

## AS 1.3—Material Specifications

All materials shall be installed according to manufacturer's instructions and shall provide a strong, airtight, permanent, durable, safe and code-compliant seal.

ASTM E-136-rated materials shall be used when air sealing materials will be in contact with chimneys, flues or other heat producing fixtures. Refer to the Air Sealing Checklist below for further requirements when air sealing around heat producing fixtures.

One-part and two-part foam shall not be used to span gaps or openings more than 1½" without a backer material and shall be installed according to manufacturer's specifications. Foam sealant will not be used where exposed to sunlight or other ultraviolet sources and will not be used near any heat-producing device.

## AS 1.4—Install Locations

Reasonable effort shall be made to seal all accessible and applicable items in the Air Sealing Checklist. All locations are considered accessible except for the following:

1. Locations not physically accessible due to building structure or mechanically fastened materials

2. Top plates located adjacent to eave line
3. Top plates covered by more than five inches of loose-fill insulation or a combination of loose-fill and batt/blanket insulation

Air leaks shall be sealed in the following order of priority:

1. The attic plane must be sealed as thoroughly as possible. If some areas are inaccessible, dense-pack and/or foam insulation should be considered to reduce air leakage
2. The walls and or ceiling separating the attached garage from the living space must be sealed
3. Basement, crawlspace or other low leaks in the building
4. Other significant leaks in the sidewalls or framing transitions
5. Penetrations and gaps in mechanical system components where they pass outside of the conditioned space

Air Sealing Checklist

| Attic | |
|---|---|
| Attic hatch/door | Weather-stripping permanently attached to create an effective air seal between the attic access frame and hatch/door |
| Pull down stair cover | Gasket or weather-stripping permanently attached between frame and door or air-tight cover installed between stairs and attic |
| Duct penetrations | Foam/caulk or other air-tight seal around perimeter of duct boots between the boot and the subfloor |
| Chases | Foam/caulk/rigid material sealed to attic floor/wall; use fire rated materials at chimneys and flues |
| Recessed cans<br>Non-IC rated | Install rigid, air tight assembly meeting ASTM E-84 requirements (e.g. gypsum board) providing 3-4” clearance on sides and 24” clearance above the top of the fixture. Cap with a vapor permeable material. Insulate up to sides of assembly but not over top of assembly |
| Recessed cans<br>IC rated | Install rigid, air tight assembly providing 3-4” clearance on sides and 24” clearance above the top of the fixture. Cap with a vapor permeable material. Insulate up to sides of assembly and over top of box |
| Recessed cans<br>IC/AT rated | Foam/caulk or other air-tight seal between fixture and ceiling. Insulate directly over fixture |
| Chimney chases and flues | Sheet metal and ASTM E-136-rated caulk shall be used within 3" of masonry chimneys and flues |
| Bath fans | Foam/caulk or other air-tight seal around fixture perimeter |
| Bath fans with heat source | Sheet metal and ASTM E-136-rated caulk |

| | |
|---|---|
| Electrical penetrations | Foam/caulk or other air-tight seal around perimeter of electrical junction box |
| Plumbing penetrations | Foam/caulk or other air-tight seal |
| Top plates | Accessible drywall to top plate connections, wood to wood seams, other wall penetrations sealed with foam/caulk |
| Drop soffits | Rigid material covering attic floor opening and sealed with foam/caulk |
| Kneewall doors | Weather-stripping permanently attached to create an effective air seal between the attic access frame and hatch/door. Install latch or handle if necessary |
| Kneewall transition (under floor paths) | Rigid material between joists; Foam/caulk perimeter of each rim joist |
| Kneewall bottom plates | Floor/floor plate connection sealed with foam/caulk |
| Open wall cavities | Rigid material sealed to attic floor/wall |
| Crawl Space | |
| Crawlspace hatch/door | Weather-stripping permanently attached to create an effective air seal between the attic access frame and hatch/door |
| Chases | Foam/caulk/rigid moisture resistant material sealed to ceiling/wall; use fire rated materials at chimneys and flues |
| Duct penetrations | Foam/caulk or other air-tight seal around perimeter of duct boots between the boot and the subfloor |
| Plumbing penetration | Penetrations sealed; Rigid moisture resistant material sealed to crawl space/basement ceiling if opening larger than 1 inch |
| Electrical penetrations | Foam, caulking; Rigid material sealed to crawl space/basement ceiling if opening larger than 1 inch |
| Other open cavities | Rigid material sealed to ceiling |
| Conditioned Basement | |
| Sill plate/stem wall | Sill plate to stem wall connection sealed with foam/caulk |
| Walls separating conditioned and exterior/unconditioned space | |

| | |
|---|---|
| Plumbing penetrations | Foam /caulk/rigid moisture resistant material if opening larger than 1 inch |
| Doors | Weather-stripping and door sweep/air-tight threshold permanently attached to create an effective air seal between interior and exterior/unconditioned space |
| Other unintentional opening | Sealed with appropriate material if accessible |
| Electrical boxes | Seal box to drywall |
| (optional) | |
| Baseboards (optional) | |
| Door & window trim (optional) | |
| Window weather-stripping (optional) | |
| Garage Separation Walls | Foam / Caulk Wall penetrations |

# AT—ATTIC INSULATION

## AT 1.0—Introduction

This section lists work and details that shall be performed before insulation is installed in attics and specifications for how to install insulation and attic-related ventilation. Insulation shall be installed to reduce heat loss between conditioned and unconditioned spaces.

To be considered a complete measure and eligible for incentives, attic insulation shall:

1. Comply with the complete measure guidelines listed in section IN 1.0
2. Be installed in an area between conditioned living space and unconditioned space that is eligible for incentives
3. Bring the connected, accessible unconditioned space into compliance with the applicable requirements listed in section AT (Refer to Illustrations AT 1.0a through AT 1.0d)

Refer to IN 1.11 for the Program procedure for determining the R-Value of existing insulation. In cases where varying levels of insulation exist in an attic, Appendix A shall be used to determine whether the whole attic area qualifies for incentives. If not, only the area of attic that meets incentive criteria shall be claimed for incentives. The Program does not require that existing insulation in attic areas be increased if the existing insulation level is greater than the incentives qualification criteria.

Situations where insulation has been contaminated by vermin shall not be used to de-rate the insulation's R-Value.

Illustrations AT 1.0a through AT 1.0d (next page) provide guidance for installing incentive-eligible attic insulation in a variety of situations.

Illustration AT 1.0a

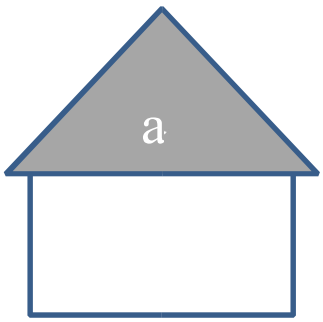
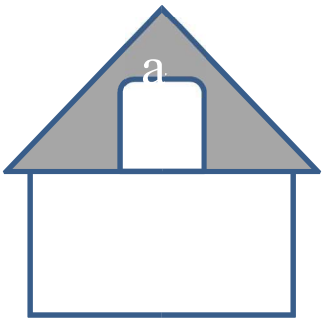



Illustration AT 1.0b




AT 1.0a: A flat attic space over the entire living space. The entire attic area "a" shall be brought into compliance with the requirements of section AT.

AT 1.0b: A rake and crown attic space with vented sloped cavities. The entire attic area "a"—all connected rakes and crown—shall be brought into compliance with the requirements of section AT.

Illustration AT 1.0c

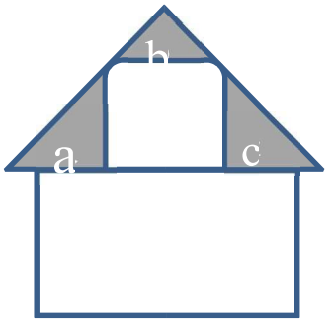
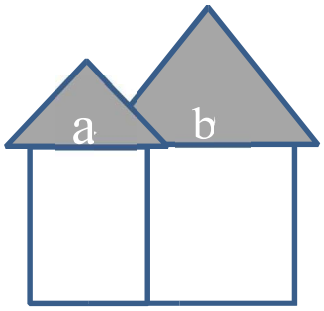



Illustration AT 1.0d




AT 1.0c: A rake and crown attic space with unvented sloped cavities. Only the specific area where attic insulation is being installed— “a,” “b” or “c”—is required to comply with section AT.

AT 1.0d: Two flat attics physically separated from one another. Only the specific area being insulated— “a” or “b” —is required to comply with section AT.

## AT 1.1—Attic Air Sealing

The Program strongly recommends, but does not require, attic air sealing prior to installation of attic insulation.

Refer to Appendix D and section AS for guidance on air sealing attics.

## AT 1.2—Passive Attic Ventilation

Enclosed attics and enclosed rafter spaces shall have cross ventilation for each separate space.

Ventilating openings shall be protected against the entrance of rain and snow. The net free-ventilating area shall be not less than 1/150 of the area of the space ventilated, except that the area may be 1/300, provided no more than 60% of the required ventilating area is provided by ventilators located in the upper portion of the space to be ventilated.

If an attic vent is used as an exhaust duct termination it shall not be included in passive attic vent area calculations.

Vent openings shall be covered with corrosion-resistant metal mesh with mesh openings of maximum 1/4 inch in dimension.

The vent area shall be the NFA, defined as the actual open area of the vent after subtracting any area blocked by screens or louvers. All vents shall be screened.

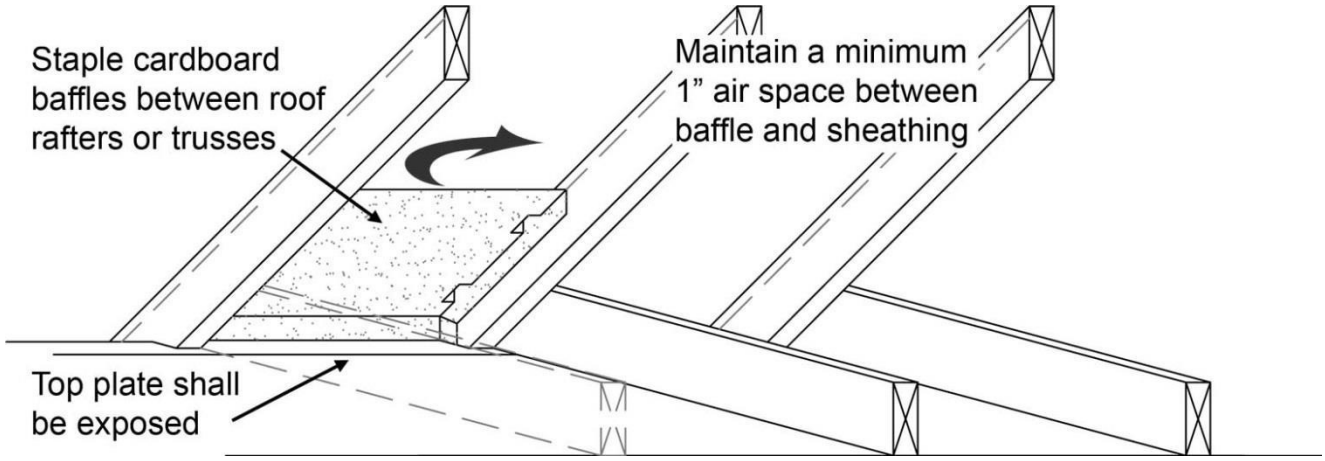
Air turbines shall not be installed in order to meet the ventilation requirements of these specifications; however, ventilating area of existing air turbines may be included by estimating the net free ventilating area of the air turbine in a locked, non-rotating position.

## AT 1.3—Baffles for Passive Attic Vents

Eave and soffit vents shall be baffled to prevent wind washing through the insulation and blockage of the vent; all insulation types shall comply. Baffles shall be installed before adding more insulation and maintain an opening equal to or greater than the size of the vent. Baffles shall be fastened to roof rafters with at least $^{9}/_{16}$" staples or roofing nails. Anchor points shall be spaced no more

than 4" apart down each side in the upper half of the baffles. Baffles shall be rigid, impervious to wind, and resistant to moisture. All baffles shall extend 4" above the final level of insulation.

Illustration AT 1.3




A continuous dam shall be installed along soffits or eaves that have vents and are completely open to the attic. Where a continuous soffit vent exists, baffles shall be installed somewhat equally spaced along the length of the soffit and allow enough NFA to satisfy the lower ventilation needs, based on the standard set in section AT 1.2. Bays that are not baffled and are open to a soffit shall be blocked and sealed with a rigid moisture-resistant material so blown product is not able to enter the soffit. Baffles shall be installed far enough into the bay to reach the exterior side of the top plate. It is acceptable for compression to occur due to a narrowing roofline. Baffle installation will allow for the highest possible RValue above the top plate of the exterior wall while maintaining 1" for proper ventilation.

Any other passive ventilation opening, such as gable or roof vents, within 6" of the final insulation level shall be baffled with a rigid material such as moisture-treated cardboard.

## AT 1.4—Dams

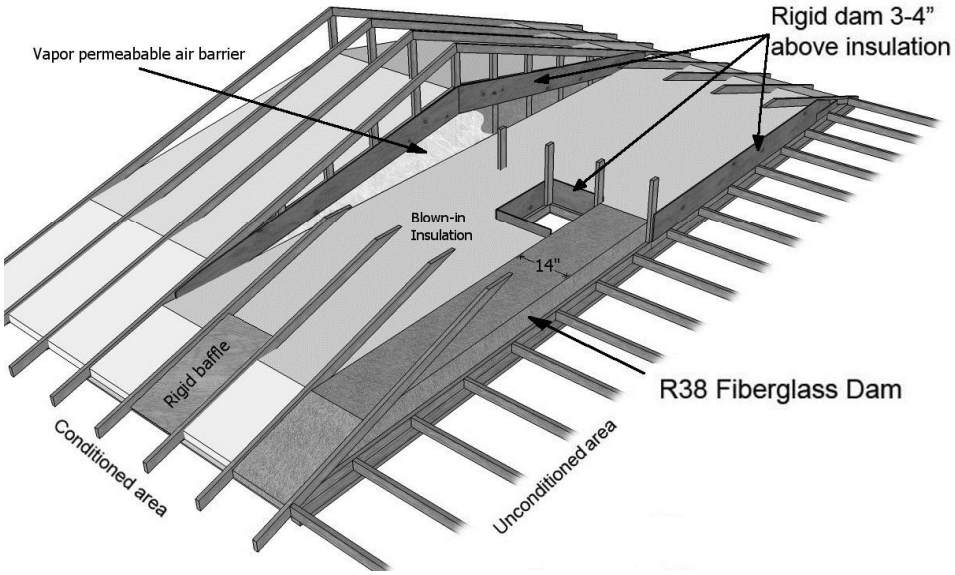
Dams shall be installed where final levels of loose-fill insulation differ. Common areas requiring a dam include raised or dropped ceilings, the sides of vaulted ceilings, and between insulated and uninsulated areas such as garages. Dams shall be installed to maintain a consistent R-Value by one of the following methods:

1. A durable, rigid material such as plywood, oriented strand board, moisture treated cardboard or foam board installed along the full length of required area and extending 4" above the final level of insulation. Rigid dams shall be mechanically and securely fastened.
2. An insulation batt a minimum of 14½" wide with an R-Value equal to or greater than that specified for the attic, laid flat along the full length of the required area. Insulation batts used as a dam shall be installed so that no gaps or voids exist.

Insulation dams as described in AT 1.10 are required around attic accesses and for porch roofs adjacent to the attic above conditioned space.

Refer to AT 1.10 for specifications for damming attic accesses, sloughing is not permitted.

Illustration AT 1.4




## AT 1.5—Baffles for Chimneys, Flues and Other Heat Sources

To prevent heat buildup, insulation shall not be in contact with fixtures as described on next page (see table 1.5b to determine baffle requirement). When needed, baffles shall keep the insulation at least 3", but not more than 4", from the sides of the heat-producing fixtures. Baffles shall extend at least 4" above the final level of insulation (See Illustration AT 1.5a).

Some un-faced fiberglass batt insulation and loose fill brands meet the ASTM E-136 noncombustible rating. Kraft paper facing does not meet this rating. Contractors may install non-combustible insulation (labeled as meeting ASTM E-136) with no clearance around double wall flues if permitted by local code. Illustration AT 1.5a

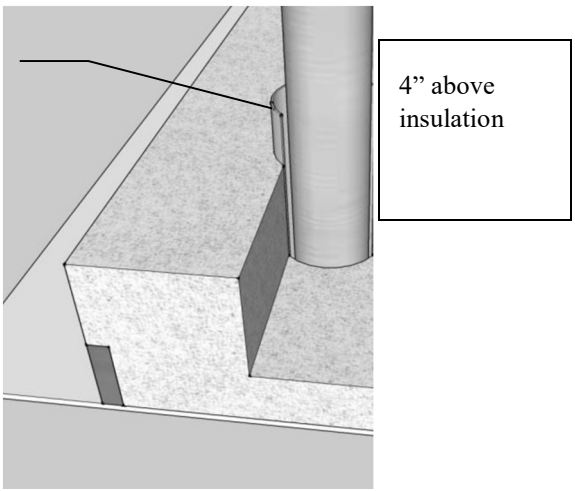


Table AT 1.5b

| Heat-Producing Fixture Type | Baffle type for insulation rated as noncombustible (ASTM E-136) | Baffle type for insulation NOT rated as noncombustible |
|---|---|---|
| Metal flue | ASTM E-136 compliant | ASTM E-136 compliant |
| Masonry chimney | No baffle required | ASTM E-84 compliant |
| Transformers | ASTM E-84 compliant | ASTM E-84 compliant |
| Non-IC-rated vented fan/heater combination | ASTM E-84 compliant | ASTM E-84 compliant |
| Miscellaneous electrical | ASTM E-84 compliant | ASTM E-84 compliant |
| Non-IC-rated recessed light | ASTM E-84 compliant | ASTM E-84 compliant |
| IC-rated recessed light | No baffle required | No baffle required |
| Vented exhaust fans | No baffle required | No baffle required |
| Extra-low voltage electrical* | No baffle required | No baffle required |
| Modern thermoplastic insulated electrical wiring | No baffle required | No baffle required |

*Extra-low voltage is defined as < $50V_{rms}$ AC, or < 120V DC.

ASTM E-136 compliant baffles are noncombustible and shall be made of rigid material (e.g. sheet metal) and secured with noncombustible mechanical fasteners.
Tape is not a mechanical fastener.

ASTM E-84 compliant baffles are fire-resistant (e.g. gypsum board). If necessary, ASTM E-84 compliant baffles shall be secured using fire-resistant fasteners. All ASTM E-84 compliant baffles shall be rigid enough to maintain the required minimum spacing (see Illustration AT 1.5a).

## AT 1.6—Bath and Exhaust Fans

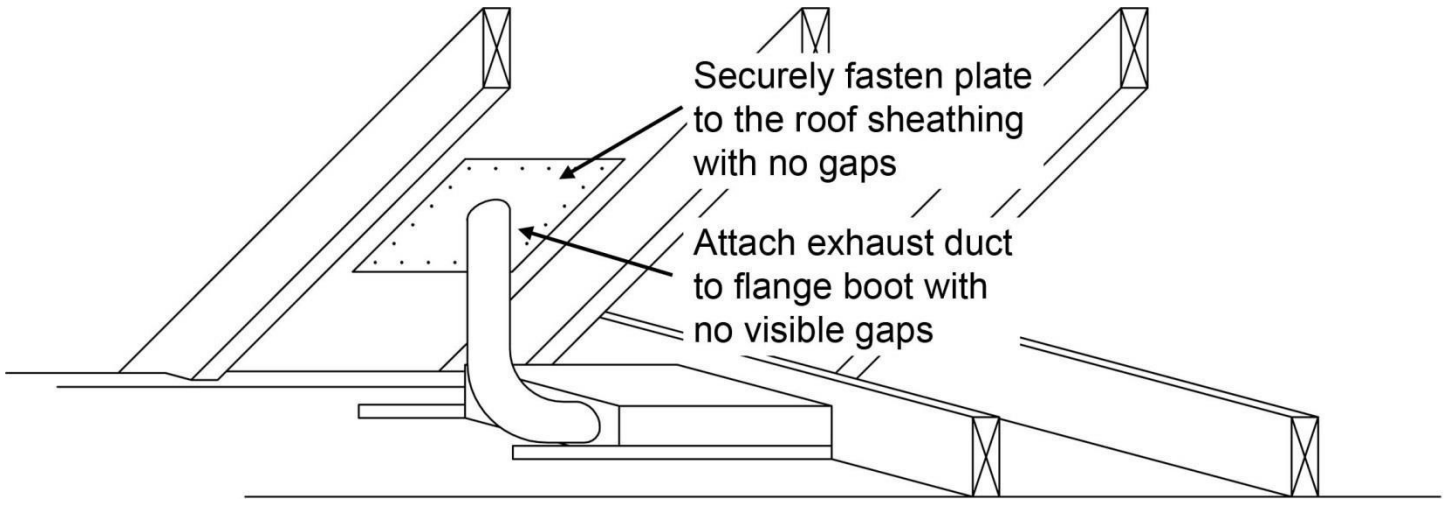
All exhaust fans shall be vented to the exterior of the structure and secured to the exterior sheathing with no gaps to prevent exhaust air from re-entering the attic (see Illustration AT 1.6). At least one functioning damper shall be present in each system, either at the fan or where vented to the outside. It is highly recommended that exhaust ducts traveling through unconditioned space be insulated to prevent condensation.

Exhaust fans shall be vented to the nearest feasible location. Vent duct shall be sheet metal or HVAC flex-duct and insulated to a minimum of R-4 when required for code compliance. Vinyl coil duct is not allowed. Vent ducts shall not sag, shall be as straight as possible to maximize effective airflow, and shall have no more than two 90-degree turns, or equivalent. Sags, turns, bends and elbows restrict air movement and effective airflow from the exhaust device. Vent duct shall be sized according to section MV. If an attic vent is used for fan exhaust, it shall not be included in attic vent area calculations (see section AT 1.2).

Vent ducts shall be securely attached at each joint and to the fan housing using mechanical fasteners, such as screws or mechanically tightened metal clamp-type straps. Mechanical fasteners shall not interfere with damper movement. The exhaust boot assembly shall be securely and mechanically fastened where it vents to the exterior of the structure (see Illustration AT 1.6). Sealing materials such as tape, caulk and foam are not acceptable mechanical fasteners. Mastic, UL listed metal HVAC tape, or mastic tape may be used to seal gaps in exhaust ducts. Duct tape is not an approved material for sealing or supporting exhaust fan ducts.

Existing flexible plastic or metal vent ducts may remain if they are free of holes and kinks and are in otherwise good condition. Existing plastic or metal ducts shall be vented to the exterior, free of gaps and sealed to prevent exhaust air from re-entering the attic.

Illustration AT 1.6—Exhaust boot connected to sheathing



## AT 1.7—Kitchen Fans

Kitchen exhaust fans shall be vented to the exterior of the structure and secured to the exterior sheathing with no gaps to prevent exhaust air from re-entering the attic. Existing rigid or flexible metal ducts may remain, but existing plastic ducts shall be replaced. Sealing materials such as tape, caulk and foam are not acceptable mechanical fasteners. Mastic, UL listed metal HVAC tape, or mastic tape may be used to seal gaps in exhaust ducts. Duct tape is not an approved material for sealing or supporting exhaust fan ducts.

If a new exhaust duct is required for a kitchen stove, it shall be at least 28-gauge galvanized steel, stainless steel, copper or aluminum and have a smooth interior surface. The exhaust duct shall be airtight and extend directly into a code approved metal vent cap. Vent duct shall be sized according to section MV.

Vent ducts shall be securely attached at each joint and to the fan housing using mechanical fasteners. The exhaust duct shall meet manufacturer's requirements and all local building codes. At least one damper shall be functioning in each system, either at the fan or where it vents to the outside. Exhaust ducting shall be insulated to a minimum of R-4 when required for code compliance.

See MV 1.2 for downdraft exhaust fan venting requirements.

## AT 1.8—Dryer Exhaust Fans

Dryer exhaust venting that travels through the attic shall comply with AT 1.6. Refer to MV 1.2 for dryer exhaust ventilation specifications.

## AT 1.9—Water Pipes in Attics

All hot and cold water pipes not enclosed within the floor insulation shall be insulated to a minimum of R-3. Leaking water pipes shall be repaired before insulating them.

All water pipe insulation shall be secured with twine, corrosion-resistant wire or plastic compression ties. Tape is not allowed to secure water pipe insulation. Do not cover the handles and spigots of safety drain valves with insulation.

Fiberglass insulation shall have a minimum finished thickness of 1", be in continuous contact with the water pipe, and be secured every 12". Insulation shall be secured to the beam at a minimum of every 12" when water pipes run next to a beam or joist.

Preformed insulation shall be properly sized. Corners shall be mitered to fit tightly. The inside diameter of the preformed insulation shall match the outside diameter of the water pipes. Preformed insulation shall be supported every 24" and within 3" of the ends. If connections and corners are larger than piping, exposed joints shall be insulated with fiberglass or preformed insulation equal to the outside diameter of the connection and corners.

## AT 1.10—Interior Attic Access Doors

All operable attic accesses opening to interior spaces shall be insulated, weatherstripped and protected from having loosefill insulation fall through the opening. Weatherstripping shall be permanently attached to create an effective air seal between the attic access frame and the door. Accesses with air leaks that cannot be weatherstripped shall be repaired or replaced prior to insulating. Weatherstripping shall not prevent easy operation of doors, latches or bolts.

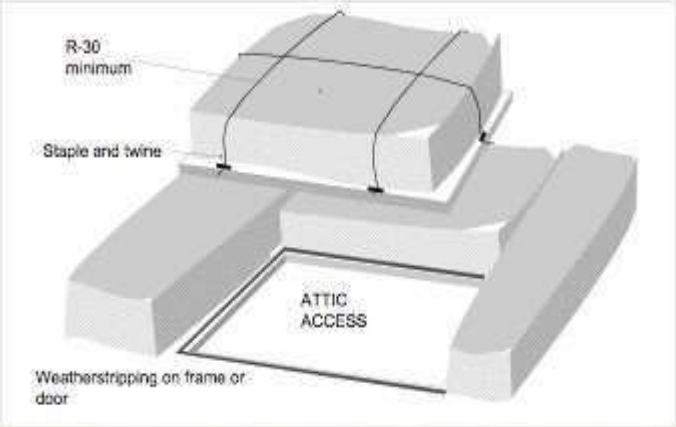
All operable accesses shall remain operable, unless the access is sealed off in favor of another existing or a newly created access. Work performed in an inaccessible area that will remain inaccessible after project completion shall be documented with photographs detailing the project's compliance with relevant specifications.

Ceiling accesses shall be insulated to R-30 with batt-type or rigid insulation. Knee wall accesses shall be insulated to a minimum of R-15.

Batt-type insulation shall be attached to the door with twine stapled to the edges of the door. Stapling the insulation directly to the door is unacceptable. Rigid insulation may be fastened to the door in lieu of batt-type insulation.

Alternatively, R-5 or greater rigid insulation installed between the access cover and a rigid protective material (OSB, plywood or other durable rigid material) attached over the entire access cover area is permissible. Insulation shall be sealed around the perimeter to the access cover using caulk, adhesive or spray foam. Access-cover assembly shall be tightly sealed using weatherstripping around the entire perimeter.

Illustration AT 1.10—Interior attic and knee wall accesses shall be insulated and weatherstripped.




Attic accesses shall be protected from having loose-fill insulation fall through the opening. The full level of ceiling insulation shall be maintained to the edge of the attic access opening by one of the following methods:

1. The opening may be framed with wood or plywood boards. The framing shall be permanently attached and extend at least 4" above the final level of insulation. Cardboard and foam board are not acceptable materials for attic access damming.
2. An insulation batt a minimum of 14½" wide laid flat, with an R-Value equal to that specified for the attic, may be placed tightly around the perimeter of the access opening. This 14½" width shall be maintained in all outward directions from the access opening, including corners. Insulation batts used as a dam shall be installed so that no gaps or voids exist.

## AT 1.11—Pull-Down Stairs

Pull-down stairs in conditioned areas shall be weatherstripped and insulated to a minimum of R-10. Insulation and weatherstripping shall not prevent easy operation of the stairs. Factory or site-built pull-down-stair covers, or airtight boxes made of foam board and sealed with caulk, shall have a minimum of R-10.

Factory-built pull-down-stair assemblies with a minimum R-5 insulation rating will be permitted provided the insulation is between conditioned space and the attic stair assembly and air infiltration is prevented by gaskets or weatherstripping.

## AT 1.12—Exterior Attic Access Doors

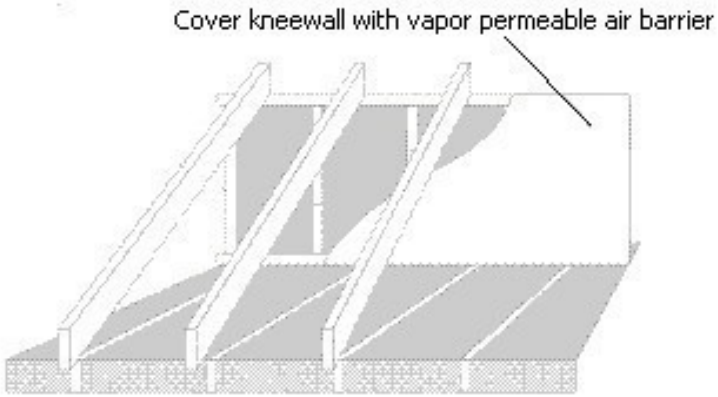
Any outside access shall have a door that is easily opened to permit inspection, and shall be weatherproof and vermin proof.

## AT 1.13—Vertical Walls in Attic Spaces

Any vertical wall in an attic that separates conditioned space from unconditioned space shall be sealed for air leaks and shall be insulated to fill the cavity. Insulation shall be secured and covered with a vapor-permeable air barrier. Vertical walls may include side walls of vaults, skylights, transitions in ceiling height or other surfaces. See AT 2.6 for Program requirements for rake and crown attics.

In cases where no wall exists between conditioned and unconditioned space, a wall shall be constructed using a rigid, permanent material, air leaks shall be sealed, and insulation shall be installed.

Illustration AT 1.13




# AT—ATTIC INSULATION: INSTALLATION

## AT 2.0—General Attic Insulation Requirements

Attic insulation shall be in contact with the conditioned area of the home and shall be installed so there is no air space between the insulation and the conditioned area.

Degradable and absorbent scrap materials, especially wood and cardboard, shall be removed from the attic. The roof and attic shall free from water leaks and moisture damage prior to performing work.

In attics with no existing insulation, vapor retarders, such as kraft facing on fiberglass batts, shall face the conditioned area of the building. New insulation with a vapor retarder shall not be installed on top of existing insulation. Insulation assemblies shall have no more than one vapor retarder, and it shall be in contact with the conditioned surface.

If existing attic insulation has a vapor retarder on its top surface, remove the vapor barrier from the insulation material, replace the insulation material, or reorient the existing insulation so vapor retarders are in contact with the conditioned surface.

If the added attic insulation compresses the existing insulation, the final R-Value shall be the Program required minimum or greater. After installing the insulation, eave and soffit vents shall remain unblocked.

## AT 2.1—Installing Loose-Fill Insulation

Loose-fill insulation shall be level and smooth with a uniform R-Value. Installation of loose-fill insulation shall comply with baffling and damming requirements as defined in AT 1.3, 1.4 and 1.5. Toward the eaves, where a sloping roof prevents insulation from being installed to Program minimums, insulation shall be installed up to the roof decking to maximize R-Value. In soffit-vented assemblies, insulation shall be installed up to the baffles. If new insulation will be blown over existing insulation, the existing insulation shall be in contact with the air barrier.

## AT 2.2—Installing Batt-Type Insulation

If batt-type insulation is installed, prepare the attic in the way described for loose-fill insulation. As stated in AT 2.0, do not install vapor retarders over existing insulation. In attic areas where no insulation exists, batts with vapor retarders may be used. The vapor retarder shall be in contact with the ceiling.

Batts shall be cut to fit and placed tightly together with no gaps, except those required for clearance around heat producing fixtures. Where practical, place one row of batts between the joists and another row of batts on top of the first row and at right angles to the joists. When lower ventilation exists, baffling is required to ensure effective R-Value and prevent wind washing of insulation. Refer to AT 1.3 for baffling requirements.

## AT 2.3—Installing Foam Insulation

When installing foam insulation products, the manufacturer’s name, product identification and information to determine the end use shall be left with the homeowner and presented to an the Program representative for review during the QA process. Foam insulation shall comply with thermal and ignition barrier code requirements for foam plastics as defined by local building code.

## AT 2.4—Floored Attics

Cavities below decked storage areas above a conditioned space shall be insulated to the highest practical level. To fill cavities, decking shall be removed or holes can be drilled no more than 4 feet apart. If loose-fill insulation is used, joist cavities shall be tightly packed with insulation. Decked storage areas shall not be included in the square footage calculation of the insulation incentives when they are insulated to less than Program minimums and exceed 5% of the attic area or 64 sq. ft., whichever is greater. When decked storage areas are less than 5% of the attic area or 64 sq. ft., they may be included in the incentives area calculation. When unusual circumstances allow for only the cavity to be filled, contact the Program for incentive information. Refer to AT 1.4 for damming requirements for decked storage areas.

## AT 2.5—Vented Vaulted Ceilings

If insulation is added to a vented vaulted ceiling, a 1" air space shall be maintained above the insulation. Each cavity shall have an upper and a lower vent.

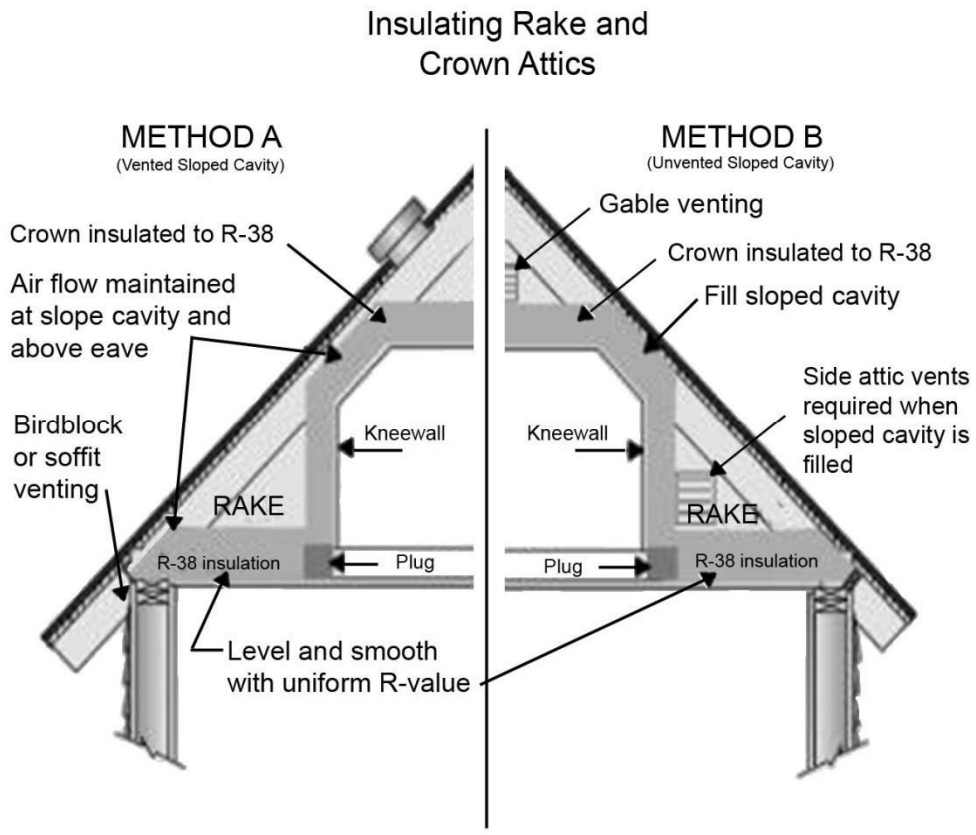
## AT 2.6—Unvented Vaulted Ceilings

If insulation is added to an unvented vaulted ceiling, it shall be filled with tightly packed insulation.

## AT 2.7—Insulating Rake and Crown Attics

When insulating rake and crown attics, a continuous thermal boundary shall be created to be considered a complete measure. If rake attics are considered unconditioned space, knee wall accesses shall be insulated to R-15 and weatherstripped to create an effective air seal. If the rake is used for storage, fibrous knee wall door insulation shall be covered to prevent human contact. Refer to IN 1.7 for further information. Foam-core doors with a minimum R-5 insulation rating (manufactured for exterior use) will be permitted in knee wall door installations, provided gaskets or weatherstripping prevent air infiltration around the entire door perimeter.

Illustration AT 2.6




Use one of the following methods to treat a rake and crown attic. In all cases, the sloped cavity and crown shall be insulated unless physical barriers exist.

Method A

If the upper and lower passive ventilation calculation requires air to move from rake to crown, a 1" air space shall be maintained between the insulation and the roof deck with continuous baffle or equivalent. Knee walls shall be sealed for air leaks and shall be insulated and covered with a vapor-permeable air barrier. Knee walls shall be treated according to this requirement, regardless of existing insulation levels. Cavities where the knee wall reaches the rake floor shall be plugged with an air barrier and sealed using caulk or foam. Rake insulation shall be in contact with plugs. Refer to Illustration AT 2.6.

Method B

If rake and crown attic spaces have adequate ventilation independently, the sloped cavity may be completely filled. Loose-fill insulation may be used as long as the lower opening of each cavity is dammed with a rigid, vapor-permeable material to prevent insulation from falling out of the cavity.

Knee walls shall be sealed for air leakage, and shall be insulated and covered with a vapor-permeable air barrier, regardless of existing insulation levels. Cavities where the knee wall reaches the rake floor shall be dammed or plugged with an air barrier and sealed using caulk or foam. Rake insulation shall be in contact with plugs. Refer to Illustration AT 2.6.

## AT 2.8—Interior Roof Insulation

Open attic spaces may be treated as conditioned space if air-impermeable insulation is installed. Air-impermeable insulation includes spray foam, rigid foam with appropriate sealants, or other materials as defined by the International Residential Code, or IRC. Insulation shall fill the roof rafter cavity, and all roof framing shall be insulated to a minimum of R-3. If rigid board is used, all seams shall be sealed using foam or caulk. Refer to IN 1.4 for foam insulation requirements.

If insulation is not considered a vapor retarder, then a vapor retarder shall be installed on the conditioned side of the insulation. If the space is intended to be habitable or if there is a combustion appliance in the zone, applicable thermal and ignition barrier requirements shall be met.

## AT 2.9—Low-Sloped, Flat Roofs and Exterior Roof Insulation

Building permits and code compliance are the responsibility of the homeowner and Trade Ally. Program preapproval is required for all low-sloped and flat roofs that cannot be insulated to Program minimum requirements.

When installing rigid insulation on top of or beneath roof sheathing, the overall assembly shall be insulated to a minimum of R-20, or recommended values stated by the International Residential Code, or the highest R-value approaching R-20 which is practical. Insulation shall not be applied to roofs over ventilated cavities. (e.g., vaulted ceilings) with ventilated spaces, attics, sloped ceilings connected to attics and/or knee wall spaces, etc. Ventilated cavities of flat or sloping roofs shall not be blocked. Insulation shall be in a rigid board form and roof drainage systems shall function after insulation is installed. Recessed lights in insulated cavities shall be Insulation Contact and Air Tight (ICAT) rated. All penetrations through the roof covering and all joints between the roof covering and vertical surfaces (e.g., walls, chimneys, etc.) shall be flashed and sealed.

# DU—DUCT SEAL AND INSULATION

## DU 1.0—Introduction

To be eligible for the Duct Seal/Duct Insulation incentive, the existing insulation shall be R-2 or less. If the R-value of the existing duct insulation or flex duct is not clearly identified, R-2 shall be interpreted as 1" of duct insulation or less. Insulation installed on ducts in conditioned space is not eligible for Program incentives. Unfinished or partially unfinished basements that contain HVAC ducts or have a direct access to the interior conditioned space of a home shall be considered conditioned space.

To be considered a complete measure and eligible for incentives, duct insulation shall:

1. Comply with complete measure guidelines listed in section IN 1.0

2. Comply with carbon monoxide alarm requirements listed in section DU 1.1
3. Provide homeowner Care for Your Air: A Guide to Indoor Air Quality (EPA)
4. Have a duct leakage test performed before and after duct sealing
5. Bring all accessible ductwork in unconditioned space into compliance with the applicable requirements listed in section DU

## DU 1.1—Combustion Safety

Duct sealing can alter the performance of combustion appliances by reducing the amount of available combustion air and can create zones of increased negative pressure. A combustion appliance is any fuel-burning appliance including ovens, dryers, water heaters, and space heating systems that utilizes natural gas, propane, oil, kerosene, or wood. Duct sealing can cause increased concentrations of pollutants and humidity within the dwelling due to reduced natural air exchanges.

It is the responsibility of the Trade Ally to ensure that all combustion appliances contained within the confines of the structure are properly and safely vented, operating, and have suitable combustion air before and after duct sealing occurs and to ensure that all applicable state/local laws, codes, and standards are met and the indoor air quality of the dwelling is not compromised.

Homes with unvented combustion heating appliances are not eligible for duct sealing incentives.

A functioning and properly installed (in accordance with manufacturer's specifications) UL-listed carbon monoxide alarm is required when a combustion appliance is present within the confines of the structure when duct sealing is performed.
Homeowners shall be made aware of the alarm and instructed how to operate, test, and maintain the alarm.

A combustion appliance zone (CAZ) is an enclosed area containing a combustion appliance for the purpose of space heating or water heating.

The Program recommends following CAZ testing procedures and requirements outlined by industry recognized organizations including, but not limited to, Building Performance Institute, RESNET, or ACCA.

## DU 1.2—Measurement

Duct leakage testing using diagnostic equipment shall be performed prior to sealing, and again after sealing is complete, to be eligible for Duct Sealing and Duct Sealing/Duct Insulation incentives. Testing shall be performed only by technicians certified by PTCS, BPI, or NATE.

A duct leakage to outside test shall be run, which involves running a blower door simultaneously, and the ducts shall be pressurized to 50 Pascals. Duct leakage testing shall be conducted according to processes outlined by The Energy Conservatory™ or Retrotec™.

A duct leakage test shall be performed before duct sealing (pre-test) and after duct sealing (post-test). In order to qualify for incentives, duct leakage to outside must be reduced by 50% or more with a 100 $CFM_{50}$ minimum reduction. Reduction in leakage shall be measured as follows:

$$\text{Total Leakage Reduction } CFM_{50} = \text{Pre-test } CFM_{50} - \text{Post-test } CFM_{50}$$

$$\text{Percent Reduction} = (1 - (\text{Post-test } CFM_{50} \div \text{Pre-test } CFM_{50})) \times 100$$

## DU 1.3—Duct Sealing

All new and all accessible existing HVAC supply and return ducts, air handlers, and plenums outside the conditioned space shall be sealed at all joints and corners, including prefabricated joints. It is unnecessary to seal longitudinal seams unless they are damaged.

### DU 1.3a—Duct Repair

Inferior sections of duct—such as rusted, crushed or disconnected sections or sections otherwise ineffective—shall be repaired or replaced before duct sealing is performed. When there are large gaps in sheet metal or duct connections, repairs shall be made using sheet metal, sheet metal screws, and/or mastic and mesh-reinforcing tape. Disconnected, loose-fitting or new metal ducts shall be secured using at least three sheet metal screws at each connection.

### DU 1.3b—Duct Support

To minimize sagging, ducts shall be supported with durable supports. Flexible ducting supports shall be listed as UL-181 approved, be at least 1½" wide and not restrict airflow. Flexible ducting shall be supported within 3' of each connection to a hard duct. If possible, ducts shall be supported above the ground. When contact with the ground is unavoidable, closed-cell rigid insulation shall be placed under the ducts.

### DU 1.3c—Duct-Sealing Materials

Ducts shall be sealed using pliable, water-based mastic labeled as meeting UL-181 standards. Gaps greater than ⅛" shall be reinforced using mesh-reinforcing tape before applying mastic. Boot-to-floor connections shall be sealed with caulking, pliable mastic or expanding foam. Foil or mastic HVAC tape labeled as meeting UL-181 standards may only be used on the air handler.

### DU 1.3d—Duct-Sealing Opportunities

All accessible connections of the supply and return plenum and trunkline, and all accessible takeoffs, runs and boots—including the gores on adjustable elbows—shall be sealed with approved materials. The following target areas are listed in order of priority:

1. Plenum
2. Plenum-to-takeoff connections
3. Remove existing loose tape before applying mastic
4. Branch Ts, Ys and Ls
5. Add three screws to each duct connection
6. Duct-to-duct connections
7. Gores on adjustable elbows
8. Finger/dovetail joints
9. Boots
10. Boot-to-floor, boot-to-wall and boot-to-ceiling connections 11. Air-handler cabinet to return and base can

The presence of insulation alone shall not be considered a barrier to accessibility.

Loose tape shall be removed from rigid ducts prior to sealing. Secured tape shall be completely covered with mastic, which shall extend at least ½" beyond the tape edge on either side and be at least ⅛" thick.

### DU 1.3e—Flexible Ductwork

All flexible ducts shall be joined to a section of rigid duct of matching diameter, including locations where two separate sections of flex duct meet. Both the inner and outer lining shall be tightly fastened using a compression strap tightened with a tool designed for that purpose. Tape may remain as long as a compression strap is installed to maintain a permanent connection. Flexible ducting shall be supported and comply with UL-181 requirements.

## DU 1.4—Duct Insulation

All ducts in unconditioned areas shall be insulated to Program minimums. Special attention shall be paid to elbows and termination areas to ensure complete coverage. Do not pull the insulation too tight as this will compress it and decrease its R-value.

Do not insulate over flex ducts or preformed fiberglass duct board, and remove duct board insulation that is R-2 or less. Insulation shall be secured to ductwork every 12" with rot-proof twine, noncorrosive wire or manufacturer-approved vinyl tape if the insulation is vinyl-backed.

Duct insulation installed in basements, garages, storage areas or other human contact areas shall be covered to limit occupant exposure to insulation fibers (see section IN 1.7). Covering shall meet applicable fire codes.

Air conditioning ducts in unconditioned spaces should have a continuous Class I vapor retarder to avoid condensation if required by code.

## DU 1.5—Manufactured Homes Duct Sealing

The definition of a manufactured home is "a structure, transportable in one or more sections" and "is built on a permanent chassis and designed to be used as a dwelling with or without a permanent foundation when connected to the required utilities, and includes the plumbing, heating, air conditioning, electrical systems contained therein" (source: Part 3280, Manufactured Home Construction and Safety Standards, Oct. 1994). For purposes of this specification, the definition of manufactured homes will also include older homes manufactured in factories and hauled over the road to the home site, and regulated by U.S. Department of Housing and Urban Development (HUD).

Where applicable, all ducts shall be installed, sealed, and supported in compliance with section
DU.

Any portion of an HVAC duct that extends beyond the last register shall be blocked off and sealed.

The crossover ducts shall be installed to prevent compressions or sharp bends, minimize stress at the connections, avoid standing water, and avoid excessive duct lengths. When skirting is not present, the crossover duct shall be protected against rodents, pets, etc. Crossover ducts shall be secured with mechanical fasteners (e.g., stainless steel worm drive clamps, plastic/nylon straps applied with tightening tool, etc.) and sealed with mastic.

Where clearances permit, the crossover duct shall be supported above the ground by strapping or blocking. Min R-4, 1” foam board between duct and ground contact is permitted.

If a non-ducted return-air system is in the floor or ceiling cavity, it shall be eliminated. Seal all return-air openings in the floor or ceiling and seal the main return-air opening in the floor or ceiling of the furnace closet. Return air shall be provided through grills in the furnace closet to the conditioned space. These grills shall be adequately sized for the installed heating system. All interior doors shall be undercut, or other means provided, to allow return air to flow back to the furnace closet.

If the rodent barrier has been removed and batt insulation has been installed in the floor, all HVAC ducts, boots and plenums shall be sealed.

# MV—MECHANICAL VENTILATION

## MV 1.0—General Requirements

Mechanical Ventilation compliance is required for homes where Air Sealing is performed. Compliance is defined as providing the required ventilation as per ASHRAE 62.2 2013 or informing the home owners of the additional mechanical ventilation required to meet ASHRAE 62.2 2013 standards.

Mechanical ventilation can be provided in both continuous and intermittent forms conforming to ASHRAE 62.2 2013 Sections 4.1 through 4.5 and 4.6. ASHRAE 62.2 2013 has a whole-house ventilation requirement along with a local (spot) ventilation requirement. Both must be satisfied to comply with the standard.

## MV 1.1—Whole House Mechanical Ventilation Required

The total continuous ventilation rate can be determined using three methods:

MV 1.1a: Using table 4.1a from ASHRAE 62.2 2013.

Table 4.1a- ASHRAE 62.2 2013 Continuous Ventilation Air Requirements, CFM

| Floor Area | # Bedrooms | | | | |
|---|---|---|---|---|---|
| ($ft^2$) | 1 | 2 | 3 | 4 | 5 |
| <500 | 30 | 38 | 45 | 53 | 60 |
| 501-1000 | 45 | 53 | 60 | 68 | 75 |
| 1001-1500 | 60 | 68 | 75 | 83 | 90 |
| 1501-2000 | 75 | 83 | 90 | 98 | 105 |

| | | | | | |
|---|---|---|---|---|---|
| 2001-2500 | 90 | 98 | 105 | 113 | 120 |
| 2501-3000 | 105 | 113 | 120 | 128 | 135 |
| 3001-3500 | 120 | 128 | 135 | 143 | 150 |
| 3501-4000 | 135 | 143 | 150 | 158 | 165 |
| 4001-4500 | 150 | 158 | 165 | 173 | 180 |
| 4501-5000 | 165 | 173 | 180 | 188 | 195 |

MV 1.1b: Using the ASHRAE 62.2 2013 equation, which is:

$$Q_{tot} = 0.03 A_{floor} + 7.5(N_{br} + 1)$$

Where:

$Q_{tot}$ = total required ventilation rate, CFM

$A_{floor}$ = floor area of residence, $ft^2$

$N_{br}$ = number of bedrooms (not less than 1)

MV 1.1c: Using an ASHRAE 62.2 2013 calculator such as the one found here: http://www.residentialenergydynamics.com/REDCalcFree/Tools/ASHRAE6222013. Calculators like these automatically figure infiltration credits, local ventilation alternative compliance, openable window allowances, and run-time. These are especially helpful when ASHRAE local exhaust flow rates are not met.

## MV 1.2—Local Exhaust Required

The local ventilation requirement can be achieved if each full bathroom receives a minimum of 50 CFM of intermittent exhaust or 20 CFM of continuous exhaust. The kitchen must receive a minimum of 100 CFM of intermittent exhaust or 5 ACH of continuous exhaust. If the local exhaust requirement is not met, the whole house ventilation rate can be increased to compensate for insufficiency of local exhaust. Certain openable windows and an infiltration credit can reduce this amount. ASHRAE 62.2 2013 calculators like the one mentioned in MV 1.1c can easily calculate this for you.

Bath & Kitchen Fans

1. All exhaust fans shall be vented to the exterior of the structure, with ducts mechanically fastened and air-sealed to the termination or the vent.
2. Any newly installed exhaust fan ducts must be sized according to Exhaust Fan Prescriptive Duct Sizing requirements, found below.
3. Exhaust ducts in unconditioned space shall be insulated to a minimum of R-4 when required for code compliance.

4. Exhaust fan ducts shall not sag, and shall be as straight as possible to maximize effective air flow, and have no more than two 90-degree turns, or equivalent.
5. Vent ducts shall be securely attached at each joint and to the fan housing using mechanical fasteners, such as sheet metal screws or a securely tightened metal clamp. Fasteners shall not interfere with damper operation.
6. Vent duct shall be sheet metal or HVAC flex-duct. Vinyl coil duct is not allowed.
7. Existing vent ducts may remain if they are free of holes and kinks and are in otherwise good condition, provided they are vented to the exterior, free of gaps, and sealed to prevent exhaust air from entering back into the attic.

Kitchen Fans

1. Non-recirculation kitchen range exhaust fan ducts shall be vented to the exterior of the structure, with ducts mechanically fastened and air-sealed to approved metal termination.
2. Venting kitchen fans to existing plastic ducts and plastic roof vents is not allowed.
3. Any newly installed kitchen exhaust fan ducts must be sized according to Exhaust Fan Prescriptive Duct Sizing requirements, found below.
4. Kitchen range exhaust fans vented through the ceiling shall be connected to a duct made of 28- gauge galvanized steel, stainless steel, aluminum, or copper (IMC 505.1) which is substantially airtight throughout and which terminates directly to the outside through an approved metal termination. Backdraft dampers are recommended.
   Existing installations that substantially meet these requirements are acceptable.

Downdraft Exhaust Fans

Downdraft exhaust ducts may have one 90-degree turn, shall exit through the foundation or exterior wall, be sealed (with no visible gaps) to a vent cap designed for kitchen exhaust. Unless otherwise allowed by local code, downdraft exhaust ducts shall comply with material requirements for Kitchen Fans.

Dryer Exhaust

Dryer exhaust ducts shall be vented to the exterior of the structure, sealed to prevent exhaust air from entering the building, shall have a back-draft damper, and shall terminate in a code-approved vent cap.

New dryer ducts shall be rigid metal and shall be securely connected with mechanical fasteners and be permanently supported. Exhaust systems shall comply with local code and manufacturer specifications, be as straight as practical, sloped downward to allow condensate drain, and shall not exceed 25 feet. To prevent blockage with lint, new dryer vent ducts shall not be connected with screws. A metal clamp or UL-rated foil tape may be used to secure dryer duct connections.

Exhaust System Makeup Air

Exhaust systems capable of exhausting in excess of 400 CFM shall be provided with makeup air at a rate approximately equal to the exhaust air rate. Such makeup air systems shall be equipped with a means of closure and shall be automatically controlled to start and operate simultaneously with the exhaust system.

Exhaust Fan Prescriptive Duct Sizing

Use table below to size new exhaust fan ducts correctly.

| Duct Type | HVAC Flex Duct | | | | | | | | Smooth Hard Duct | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fan Rating in CFM | 50 | 80 | 100 | 125 | 150 | 200 | 250 | 300 | 50 | 80 | 100 | 125 | 150 | 200 | 250 | 300 |
| Duct Diameter | Maximum Duct Length in Feet | | | | | | | | | | | | | | | |
| 3” | X | X | X | X | X | X | X | X | 5 | X | X | X | X | X | X | X |
| 4” | 56 | 4 | X | X | X | X | X | X | 114 | 31 | 10 | X | X | X | X | X |
| 5” | NL | 81 | 42 | 16 | 2 | X | X | X | NL | 152 | 91 | 51 | 28 | 4 | X | X |
| 6” | NL | NL | 158 | 91 | 55 | 18 | 1 | X | NL | NL | NL | 168 | 112 | 53 | 25 | 9 |
| 7” | NL | NL | NL | NL | 161 | 78 | 40 | 19 | NL | NL | NL | NL | NL | 148 | 88 | 54 |
| 8” | NL | NL | NL | NL | NL | 189 | 111 | 69 | NL | NL | NL | NL | NL | NL | 198 | 133 |
| Table assumes no elbows. Deduct 15 ft of allowable duct length for each elbow. | | | | | | | | | | | | | | | | |

Table from ASHRAE Standard 62.2 2013, page 8, Table 5.3.

X= Duct size not permitted

NL= No limit

## MV 1.3—Whole House Mechanical Ventilation

Ventilation provided by the whole-house mechanical ventilation system shall provide air flow to meet required continuous flow rates as calculated in section MV 1.1. Air flow rates shall be tested by the Trade Ally and not based on the rated air flow rate of the fan.

The whole-house mechanical ventilation system shall run automatically either continuously or intermittently on a timer. Systems designed to provide intermittent ventilation shall comply with ASHRAE 62.2 2013 section 4.5 or use a ventilation calculator to determine flow rates and run times.

Exhaust Fans

Exhaust fans installed for whole house mechanical ventilation purposes shall be ENERGY STAR compliant, have a sone level of 1 or less, and be rated for continuous operation.

Heat Recovery Ventilation

Energy or Heat Recovery Ventilators installed for whole-house mechanical ventilation purposes shall be certified and listed in the Home Ventilating Institute directory, shall be ENERGY STAR compliant and rated for continuous operation.

Any ducts installed as part of a Heat Recovery Ventilation system shall comply with section DU.

Bathroom Fans as Whole-House Fans

Bathroom exhaust fans may be used to provide whole house ventilation as well as bathroom spot (local) ventilation provided all of the following conditions are met:

1. A minimum 1" clearance under the bathroom door to provide for a clear air pathway to the rest of the house when the bathroom door is closed. Or an alternative equivalent means of providing a clear air pathway is installed.
2. The fan shall have both automatic and manual controls.
3. The fan is set to run automatically either continuously or intermittently on a timer.
4. There is a manual control switch for spot-ventilation purposes.
5. All conditions of Bath Fan requirements must be met in section MV 1.2.

Fresh Air Inlets

Air inlets that are part of the ventilation system shall be located a minimum of 10 feet from known sources of contamination such as stack, vent, exhaust hood, or vehicle exhaust. The intake shall be placed so that entering air is not obstructed by snow, plantings, or other material. Inlets shall have rodent/insect screens with mesh not larger than ½ inch.

# WA—WALL INSULATION

## WA 1.0—Introduction

This section applies to exterior walls and buffered walls adjacent to unconditioned areas, such as garages. Insulation shall be installed to reduce heat loss between conditioned and unconditioned spaces or to the outside of the house. Basement walls, conditioned crawlspace walls, and below grade walls do not qualify.

To be eligible for an incentive, the existing wall insulation shall not exceed pre-existing Program limits, and all cavities in all exterior walls shall be insulated to Program minimums or completely filled.

To be considered a complete measure and eligible for incentives, wall insulation shall:

1. Bring all accessible wall areas that are eligible for incentives to the R-Value specified by current Program qualifications (refer to IN 1.0)
2. Bring the accessible wall areas affected by the insulation project into compliance with the applicable requirements listed in Section WA

## WA 1.1—Knob and Tube Wiring

Refer to IN 1.2 for Program requirements regarding knob and tube wiring.

Enclosed wall cavities with active knob and tube wiring may be left uninsulated as long as this area is equal to or less than 10 percent of the total uninsulated exterior wall area of the conditioned space. This area shall not be eligible for incentives.

### WA 1.2—Insulating Closed Walls

This subsection refers to exterior walls and buffered walls adjacent to unconditioned areas, such as garages. Refer to AT 1.13 for Program requirements for buffered walls adjacent to attics. All cavities in all walls shall be filled, including small cavities above, below and to the side of windows and doors. Use of an infrared camera is strongly encouraged to identify such cavities, and due diligence shall be applied to ensure a consistent level of insulation.

Insulation shall not be installed in wall cavities that serve as air ducts for heating or cooling. Cavities containing wallmounted heaters shall not be insulated unless there is blocking to prevent contact with insulation. Cavities containing fuse or breaker boxes shall not be insulated without the homeowner's consent. Only non-combustible insulation (per ASTM E-136) shall be installed in wall cavities adjoining fireplaces and/or chimneys.

### WA 1.3—Plugs and Finish Work

Plugs shall be sealed, weatherproofed and ready to paint. Plugs shall not be vented. Plugs shall be made of material that will not shrink or expand, which would result in damage to the siding or finish. If the surface of the plug is below the surface of the siding, the hole shall be filled with non-shrinking, waterproof filler. If siding is removed and holes are drilled in the sub-siding, the holes shall be plugged.

### WA 1.4—Removing and Replacing Siding

Before replacing siding, holes shall be filled with fitted plugs, covered with tar paper, counter flashed, and stapled. Shingles or shakes shall be nailed every 4" with a minimum 4d galvanized finish nail and at each corner. Clapboard-type siding shall be nailed at every wall stud or 16" on center. All replaced siding shall use galvanized or corrosion-resistant nails and be reinstalled in a professional manner. Any raw wood shall be primed or sealed.

### WA 1.5—Open Wall

Open walls that separate conditioned and unconditioned spaces, such as garages adjacent to a conditioned space, shall be sealed for air leakage, insulated to Program minimums (or the cavity shall be filled), and covered with a vapor-permeable air barrier to limit human contact in compliance with the requirements of AT 2.6. See IN 1.8 for the eligibility requirements for homes without intact interior wall coverings.

### WA 1.6—Interior Installations

Walls that are inaccessible from the exterior shall be filled from the interior, with the homeowner's permission.

## PART 2: MECHANICAL SYSTEMS

This section covers technical specifications required when installing HVAC and plumbing equipment for program incentives.

To be considered a complete measure and eligible for incentives, mechanical installations shall:

1. Comply with the complete measure guidelines listed in section IN 1.0
2. Comply with requirements regarding code compliance and manufacturer's specifications as outlined in IN 1.1 and 1.12.

## CAC and HP 1.0—Introduction

This section governs installation requirements for ducted and ductless heat pump systems and central air conditioners.
Refer to IN 1.2, IN 1.3, IN 1.14, IN 1.15 and IN 1.16 for additional requirements.

The contractor shall ensure evaporators and condensing units are compatible with one another according to AHRI specifications.

Refer to Appendix D for additional best practices regarding ducted and ductless heat pump systems.

## CAC and HP 1.1—Thermostat

A programmable thermostat with the ability to program a temperature setback shall be installed. The temperature setback shall be no more than 3 degrees Fahrenheit to maximize energy-efficient operation.

For heat pumps, the balance point shall be within 5 degrees (plus or minus) of 30°F.

## CAC and HP 1.2—Line Set Requirements

Line set penetrations through the building shell shall be sealed.

Outdoor portions of the line set shall be protected with a mechanically secured rigid covering. In situations where installation of a rigid cover is impractical, a securely fastened UV-resistant covering may be used to protect the line set.

The line set shall be insulated over its entire length. For ducted heat pumps and central air conditioners, the liquid line may be uninsulated.

## CAC and HP 1.3—Outdoor Unit Installation

The outdoor unit shall rest on a permanent pad on a stable, level surface.

The outdoor unit shall not be covered with debris or have obstacles nearby that restrict or prevent airflow over the unit.

## HP 1.4—Additional Requirements for Ductless Heat Pumps

Ductless heat pumps shall be installed in accordance with the requirements listed in HP 1.0, HP 1.2 and HP 1.3.

### HP 1.4a—Outdoor Unit Installation

Set outdoor unit on a pad placed on a stable, level surface; secure unit to pad using bolts and/or adhesive. In lieu of pad mounting, the outdoor unit may be wall mounted using hardware designed specifically for this purpose and installed per the manufacturer's instructions and recommendations. If using wall-mount brackets, use vibration mounts to prevent noise concerns.

In cold climates, elevate the unit to maximize clearance under the outdoor unit for easy drainage and reduced snow and ice buildup.

New tubing flares shall be created and connected with the R410A nuts (supplied with your indoor and outdoor unit). Flare nuts provided by the tubing manufacturer shall not be used.

### HP 1.4b—Indoor Unit Installation

The indoor unit shall be securely mounted, level and plumb per the manufacturer's specifications to a permanent surface (wall, soffit, partition, etc.). Mounting to movable walls or partitions is not allowed.

Condensate drain should slope downhill and run to a suitable termination point away from crawlspaces and walkways. Condensate pumps shall not be used unless no other reasonable solution for adequate drainage is feasible.

## WH—HEAT PUMP WATER HEATERS

### WH 1.0—Introduction

This section governs installation requirements for heat pump water heaters. Refer to IN 1.2, IN 1.3, IN 1.14, IN 1.15 and IN 1.16 for additional requirements. See Appendix D for additional best practices regarding heat pump water heaters.

### WH 1.1—Installation

The heat pump condensate shall be removed from the area of installation via an adequately sloped drainage system, condensate pump or connection to an existing plumbing drain. If drained to the outdoors, avoid creation of a slip hazard over sidewalks and driveways.

Ensure the unit location meets manufacturer space requirements and that the unit has adequate manufacturer recommended clearances around and above the unit.

## APPENDIX A: WEIGHTED ATTIC R-VALUE TABLES

These tables shall be used to determine the weighted R-Value of a single attic space with varying levels of insulation. These figures are determined by using a weighted average R-Value calculation without including framing assembly UValues:

$$\text{U-Value (U)} = 1 \div \text{R-Value Area (A)}$$
$$= \text{area in sq. ft.}$$
$$\text{Weighted R-Value} = 1 \div [(U_1A_1 + U_2A_2) \div (A_1 + A_2)]$$

In cases where the existing insulation level is R-0, an R-Value of R-1 is used in its place to determine weighted R-Value.

| 50% larger, 50% smaller | Larger Area R-Value | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Smaller Area R-Value | 0 | 4 | 7 | 11 | 14 | 19 | 24 | 30 | 38 |
| 0 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 4 | 2 | 4 | 5 | 6 | 6 | 7 | 7 | 7 | 7 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 7 | 2 | 5 | 7 | 9 | 9 | 10 | 11 | 11 | 12 |
| 11 | 2 | 6 | 9 | 11 | 12 | 14 | 15 | 16 | 17 |
| 14 | 2 | 6 | 9 | 12 | 14 | 16 | 18 | 19 | 20 |
| 19 | 2 | 7 | 10 | 14 | 16 | 19 | 21 | 23 | 25 |
| 24 | 2 | 7 | 11 | 15 | 18 | 21 | 24 | 27 | 29 |
| 30 | 2 | 7 | 11 | 16 | 19 | 23 | 27 | 30 | 34 |
| 38 | 2 | 7 | 12 | 17 | 20 | 25 | 29 | 34 | 38 |

| 60% larger, 40% smaller | Larger Area R-Value | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Smaller Area R-Value | 0 | 4 | 7 | 11 | 14 | 19 | 24 | 30 | 38 |
| 0 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 4 | 1 | 4 | 5 | 6 | 7 | 8 | 8 | 8 | 9 |
| 7 | 2 | 5 | 7 | 9 | 10 | 11 | 12 | 13 | 14 |
| 11 | 2 | 5 | 8 | 11 | 13 | 15 | 16 | 18 | 19 |
| 14 | 2 | 6 | 9 | 12 | 14 | 17 | 19 | 21 | 23 |
| 19 | 2 | 6 | 9 | 13 | 16 | 19 | 22 | 24 | 27 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 24 | 2 | 6 | 10 | 14 | 17 | 21 | 24 | 27 | 31 |
| 30 | 2 | 6 | 10 | 15 | 18 | 22 | 26 | 30 | 34 |
| 38 | 2 | 6 | 10 | 15 | 19 | 24 | 28 | 33 | 38 |

| 70% larger, 30% smaller | Larger Area R-Value | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Smaller Area R-Value | 0 | 4 | 7 | 11 | 14 | 19 | 24 | 30 | 38 |
| 0 | 1 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| 4 | 1 | 4 | 6 | 7 | 8 | 9 | 10 | 10 | 11 |
| 7 | 1 | 5 | 7 | 9 | 11 | 13 | 14 | 15 | 16 |
| 11 | 1 | 5 | 8 | 11 | 13 | 16 | 18 | 20 | 22 |
| 14 | 1 | 5 | 8 | 12 | 14 | 17 | 20 | 22 | 25 |
| 19 | 1 | 5 | 9 | 13 | 15 | 19 | 22 | 26 | 29 |
| 24 | 1 | 5 | 9 | 13 | 16 | 20 | 24 | 28 | 32 |
| 30 | 1 | 5 | 9 | 14 | 17 | 21 | 26 | 30 | 35 |
| 38 | 1 | 5 | 9 | 14 | 17 | 22 | 27 | 32 | 38 |

| 80% larger, 20% smaller | Larger Area R-Value | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Smaller Area R-Value | 0 | 4 | 7 | 11 | 14 | 19 | 24 | 30 | 38 |
| 0 | 1 | 3 | 3 | 4 | 4 | 4 | 4 | 4 | 5 |
| 4 | 1 | 4 | 6 | 8 | 9 | 11 | 12 | 13 | 14 |
| 7 | 1 | 4 | 7 | 10 | 12 | 14 | 16 | 18 | 20 |
| 11 | 1 | 5 | 8 | 11 | 13 | 17 | 19 | 22 | 25 |
| 14 | 1 | 5 | 8 | 11 | 14 | 18 | 21 | 24 | 28 |
| 19 | 1 | 5 | 8 | 12 | 15 | 19 | 23 | 27 | 32 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 24 | 1 | 5 | 8 | 12 | 15 | 20 | 24 | 29 | 34 |
| 30 | 1 | 5 | 8 | 13 | 16 | 21 | 25 | 30 | 36 |
| 38 | 1 | 5 | 8 | 13 | 16 | 21 | 26 | 31 | 38 |

| 90% larger, 10% smaller | Larger R-Value Area | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Smaller Area R-Value | 0 | 4 | 7 | 11 | 14 | 19 | 24 | 30 | 38 |
| 0 | 1 | 3 | 4 | 6 | 6 | 7 | 7 | 8 | 8 |
| 4 | 1 | 4 | 7 | 9 | 11 | 14 | 16 | 18 | 21 |
| 7 | 1 | 4 | 7 | 10 | 13 | 16 | 19 | 23 | 26 |
| 11 | 1 | 4 | 7 | 11 | 14 | 18 | 21 | 26 | 31 |
| 14 | 1 | 4 | 7 | 11 | 14 | 18 | 22 | 27 | 32 |
| 19 | 1 | 4 | 7 | 11 | 14 | 19 | 23 | 28 | 35 |
| 24 | 1 | 4 | 8 | 12 | 15 | 19 | 24 | 29 | 36 |
| 30 | 1 | 4 | 8 | 12 | 15 | 20 | 24 | 30 | 37 |
| 38 | 1 | 4 | 8 | 12 | 15 | 20 | 25 | 31 | 38 |

## APPENDIX B: QUICK REFERENCE GUIDE

(R-Values in Tables 1–4 are typical and intended as guides when specific manufacturer information is unavailable.)

TABLE 1:

| Insulation Material | R-Value (per inch) | Description (typical) |
|---|---|---|

| | | |
|---|---|---|
| Fiberglass loose fill* | 2.5 | Colors: pink/white/yellow |
| Fiberglass batts (blanket)* | 3.2 | pink/white/yellow |
| Cellulose fiber* | 3.5 | Light gray/recycled paper products |
| Rockwool loose fill* | 2.8 | Black/gray, similar to fiberglass |
| Vermiculite or Perlite* | 2.7 | Silver/brown, mica-like |
| New cellulose fiber** | 3.5 | pink/white/yellow |
| New fiberglass loose fill** | 2.9 | pink/white/yellow |

* Indicates derating due to effects of aging and settling

** Indicates value used by during quality assurance inspections if brand or R-value is unknown of new product installed

TABLE 2:

| Existing Fiberglass Loose Fill | R-Values |
|---|---|
| 3.5" | 9 |
| 5" | 12.5 |
| 6" | 15 |
| 7" | 17.5 |
| 8" | 20 |
| 9" | 22.5 |
| 10" | 25 |
| 12" | 30 |
| 15"–17" | 38 |

| Existing Rockwool Loose Fill | R-Values |
|---|---|
| 3.5" | 10 |
| 5" | 14 |
| 6" | 17 |

| | |
|---|---|
| 7" | 20 |
| 8" | 22.5 |
| 9" | 25 |
| 10" | 28 |
| 12" | 34 |
| 15" | 42 |

TABLE 4:

| Existing Cellulose Loose Fill | R-Values |
|---|---|
| 4" | 12 |
| 5" | 17.5 |
| 6" | 21 |
| 7" | 24.5 |
| 8" | 28 |
| 9" | 31.5 |
| 10" | 35 |
| 11" | 38.5 |
| 12" | 42 |

## APPENDIX C: GLOSSARY

ACCA—Air Conditioning Contractors of America

AFUE—Annual fuel utilization efficiency. Used for gas furnaces and boilers, this rating factors in fuel combustion inefficiencies, exhaust flue heat loss, and heat loss from the appliance itself.

AGA—American Gas Association

AHRI—Air-Conditioning, Heating and Refrigeration Institute

Air barrier—A continuous barrier to air movement that separates interior (conditioned) space from exterior (unconditioned) space. An air barrier is created by sealing all penetrations to unconditioned space with durable materials.

Air Changes per Hour (ACH)—The rate at which the full volume of air of a conditioned space is replaced with unconditioned air over the course of one hour, due to natural conditions. $ACH_{50}$ is the number of times this replacement occurs at a constant pressure of 50 pascals.

Air sealing targets areas—Locations of high importance for effective air sealing, including attic and basement hatches; plumbing and electrical penetrations; large gaps in walls or exterior surfaces; and framing around windows and doors.

ANSI—American National Standards Institute

ASTM—American Society for Testing and Materials

ASTM E-136—A rating for noncombustible materials. Examples include sheet metal and rated caulks. These materials are appropriate for air sealing around a chimney or flue. Products meeting this rating will have the ASTM E-136 rating on the label. No foam meets this rating.

ASTM E-84—A flame spread rating for building materials. Examples include materials made out of mineral, wool, foilfaced fiberglass board and fire-treated corrugated cardboard. Products meeting this rating will have the ASTM E-84 rating on the label.

ASTM E-814—A rating for an assembly of materials that inhibits the spread of fire and hot gases through a home. Examples include gypsum board and ASTM E-814-rated foam and caulk. These materials are appropriate for air sealing and may be required by code in some locations.

Auxiliary heat—Applies only to heat pump systems. Electric resistance coils activated when the outdoor temperature is below the heat pump's balance point. Also known as strip heat, second-stage heat, supplemental heat, emergency heat, and backup heat.

Baffles—Rigid material used to contain loose-fill insulation.

Balance point— The point at which a ducted heat pump no longer has capacity to meet 100% of the home's load resulting in the need for auxiliary heat.

Building cavity duct—Any enclosed cavity used for a forced-air duct system. This includes joists where sheet metal forms a pan across the joists.

CAC – Central Air Conditioner

Combustion appliance—Any fuel-burning appliance, including ovens, dryers, water heaters and heating systems, that utilize natural gas, propane, oil, kerosene or wood.

Combustion Appliance Zone (CAZ)—A conditioned space or enclosed area containing a combustion appliance for the purpose of space heating or water heating. Refer to IN 1.12 for general Program requirements, to MA 3.0 for testing procedures for Existing Manufactured Homes projects, and to Appendix D for additional guidelines.

Complete measure—An installation of an Energy Trust incentive-qualifying measure that meets all requirements in the Specifications Manual and the minimum requirements at all reasonably accessible locations. For example, attic insulation shall be R-38 over the entire surface adjacent to conditioned space and ducts shall be sealed at every joint and seam.

Condensate drain—Any drainage system that allows condensation created by condensing gas heating appliances and heat pump equipment to flow into a dedicated drain or outside a building enclosure.

Conditioned basement—Any basement that contains HVAC ducts and/or is accessible from another conditioned space. Other basements may be considered conditioned if they are largely connected to the conditioned space of the house and separated from the outside.

Conditioned space—An enclosed area within a building that is heated and designed, or modified, to have a complete and effective pressure boundary. Garages, barns, unattached shops, sheds, unfinished attics and crawlspaces are considered unconditioned space for the purposes of incentive qualification. Garages are defined as any space, whether heated or not, that feature a large door designed to permit the entry of an automobile. Contact the Existing Homes Program for more information.

Connected area—For purposes of incentives eligibility, an area is considered connected to another area if there is not a complete physical separation between the two. For example, in a half story that has rake attics, a crown attic, and vented sloped cavities between the two, the rake and crown attics are considered connected by the vented sloped cavities.

Crown attic—Uppermost attic flat, adjacent to a sloped cavity; commonly seen in one-and-a-half-story homes.

Cubic feet per minute (CFM)—Rate of flow for air movement between defined areas. $CFM_{50}$ is the rate of air flow at a constant pressure of 50 pascals.

Direct vented appliance—A combustion appliance that pulls outside air for combustion and vents combustion gases directly outside.

ECM – Electronically Commutated Motor

EER – Energy Efficiency Ratio

Electric Cooling – Permanently installed, electric heat pump or ducted electric central air conditioner serving as the home's current primary cooling source. Room air conditioners and evaporative cooler do not qualify

Electric heating – Permanently installed, ducted system consisting of an electric furnace, heat pump with electric resistance backup, or electric zonal heating system (baseboard or ceiling/wall heaters) serving as the home's current primary heat source (space heaters do not qualify). Heat pumps with gas backup are not considered electric heating for the purposes of the Program.

Encapsulated batts—Fiberglass batts with a perforated vinyl cover. Can serve as a vapor-permeable air barrier in human contact/storage areas and are acceptable for installations.

Enclosed cavity—Space bordered on all sides by rigid material.

Exhaust device—A mechanical unit intended to remove indoor air pollutants, including bathroom exhaust fans, dryers and mechanical ventilation devices.

Exterior attic access—Entry into unconditioned attic space directly connected to other unconditioned areas, including garages and outside.

Faced batt-type insulation—Faced batts have an air and/or vapor barrier on one side, usually made of kraft paper.

Flex duct—Flexible plastic sheeting over a metal wire coil.

Ground cover—Six-mil or thicker black polyethylene used to prevent water vapor from emanating from soil in unfinished crawlspaces or basements.

HES – Home Energy Savings

HSPF—heating seasonal performance factor. Records the number of BTUs of heat delivered for each watt-hour of electricity used. Factors in both the high-efficiency compressor and the less-efficient electric resistance backups.

Human contact area—Location where occupants go for routine maintenance or storage.

HVAC—heating, ventilation and air conditioning. Refers to components of a home's mechanical systems that provide space heating and cooling.

IC-rated light fixtures—Insulation Contact-rated fixtures do not need to be baffled to prevent insulation from contact. Insulation may be piled directly on top of fixture. An ICAT fixture is a type of IC-rated light fixture that is manufactured as an airtight unit.

Ignition barrier—A material rated to inhibit the development of flame across its surface, often placed between a known combustible material and a potential heat source.

Interior attic access—Entry into unconditioned attic space directly connected to a conditioned area.

Knee wall—A short wall between an attic floor and a sloping roof that separates a conditioned and unconditioned space.

Minimum ventilation level (MVL)—Level of a structure's natural ventilation, below which mechanical ventilation is required.

Non-electric heating— Heating system with gas, oil, wood, pellet stoves, and propane serving as the home's current primary heat source

Net Free Area (NFA)—The net area of properly baffled passive ventilation; the total area of the vent minus the area blocked by screens or louvers.

Open wall(s)—Any vertical barrier between conditioned and unconditioned space where the framing is visible from any side.

Pa – Pascal
Passive ventilation—Natural ventilation of a space caused by wind or temperature-driven convection. Does not include moving parts such as fans.

Performance-based duct sealing—Sealing ductwork in compliance with PTCS guidelines, which includes the use of a pressure test to evaluate the duct system's air leakage to outside, both before and after work is performed.

Post and beam—Floor construction using a support system of beams typically spaced 30"–48" on center. See UN 2.2 for spacing/spans.

Prescriptive duct sealing—Sealing ductwork in compliance with Program guidelines, without the use of pressure diagnostic tests to identify and quantify air leakage to outside.

Primary heating system—The main heating equipment that is permanently installed and designed to provide the majority of heat inside a home, regardless of use or condition. Existing Homes cash incentives are available for homes with an electric or natural gas primary heating system with fuel provided by Portland General Electric, Pacific Power, NW Natural Gas or Cascade Natural Gas.

QPL – Qualified Products List

R-Value—Measurement of a material's thermal resistance, commonly used to describe insulation materials. An increase in R-Value results in an increase in thermal resistance. R-Value is the inverse of U-Value (R = 1/U).

Rake—Horizontal section of side attic.

Register—A ventilation grill separating HVAC ducting from conditioned space.

Return—Duct that brings conditioned air from the house to the air handler.

Rim or band joist—Area of a home where the concrete foundation meets the floor joists.

RMP – Rocky Mountain Power

SEER—seasonal energy efficiency ratio. SEER compares the number of BTUs of heat removed per watt-hour of electricity used on a seasonal basis.

Side attics—Unfinished areas located on the same floor as, and adjacent to, finished spaces. May be considered conditioned or unconditioned, depending on certain criteria.

Skylight—Any window unit in an opening in the roof assembly, including one that is installed at a slope of 15 degrees from vertical or greater.

Sloped ceilings—Angled ceilings, including vaults, over conditioned spaces that may follow the roof line or intrude into the attic space above and may require special consideration when installing insulation.

Spray-foam insulation—A foam-plastic material applied with a foaming agent for use as insulation.

Steady state—Heating equipment, such as a gas furnace, enters a steady state when all heating-related components reach the temperature at which they will remain until the end of the heating cycle.

Supply—Delivers conditioned air from the air handler into the home.

Thermal barrier— A material rated to resist heat and flame transmission across its surface, significantly slowing flame spread and limiting the potential fuel source available to an open flame.

Thermal boundary—Any surface or building material that serves to resist the transmission of heat energy between conditioned and unconditioned space.

Thermal envelope— The collection of all surfaces and building materials in a structure that resist air loss and heat transmission between conditioned and unconditioned space. Often referred to as the "building envelope."

TXV – Thermal Expansion Valve

U-Value—Measurement of a material's thermal transmission, commonly used to describe windows, doors and skylights. A decrease in U-Value results in a decrease in thermal transmission. U-Value is the inverse of R-Value (U = 1/R).

Unconditioned space—Space within a building that is not heated or cooled by an active system or directly linked to conditioned space; outside.

Unfaced batt-type insulation—Batt-type insulation with no vapor or air barrier attached.

Upper attics—Unfinished areas located above finished spaces. Upper attics are usually considered unconditioned space, except in rare cases.

Vapor barrier—A material restricting the movement of water vapor from an area of high vapor pressure to one of lower pressure. Material with a perm rating of 1.0 or less is normally considered a vapor barrier.
Vapor-permeable air barrier—Any material, including house wrap, that substantively blocks air from passing, but allows water vapor to pass through via pores that are narrower than air.

WCI – Water Column Inches

Weatherization measure—Installation of insulation, air sealing, duct sealing and/or windows.

Weather-resistant barrier—The outermost surface in the building envelope that is specifically designed to prevent water/moisture from entering a building or building cavity. Aluminum or vinyl siding is not considered a weatherresistant barrier.

Wintertime conditions— A scenario where all overhead garage doors, exterior doors, windows, flues and dampers are closed, all interior doors and duct registers are open, and all ventilation fans are shut off. Used to perform performance based air leakage and duct leakage tests.

## APPENDIX D: BEST PRACTICE GUIDELINES

This appendix lists best practice guidelines for installing high-quality, long-term energy-efficiency measures, equipment, and services. Guidelines contained in this appendix are not Program requirements. They are intended to provide beneficial advice when performing energy efficiency upgrades.

Best Practice: Air Sealing
The Program recommends including a mechanical ventilation strategy as part of the scope of work if air sealing may result in occupant health and safety concerns and/or building durability concerns.

Air sealing is not recommended if a visual inspection determines the home has obvious indoor air quality concerns.

Best Practice: Attic Insulation
The Program recommends all ducts in attic spaces to be sealed according to section DU so the energy-saving opportunity is not lost after insulation is installed.

Existing pest or moisture problems should be addressed to ensure measure and building durability.

An attic insulation certificate should be displayed in plain view of the access hatch that details square footage of insulation installed, bag count, initial R-value, finished R-value, brand, and date installed.

To prevent water vapor transmission and support the effective R-Value of the attic insulation, the Program recommends sealing all accessible attic penetrations between conditioned and unconditioned space. Attic air sealing opportunities include plumbing, wiring and duct penetrations, top plates, mechanical chases, soffits and similar openings in the air barrier of the attic. When air sealing, appropriate backing materials should be used to bridge openings that cannot be effectively closed by a sealant. Caulk, foam or other compatible sealants should be used. See the Section AS in this manual for additional guidelines.

Best Practice: Wall Insulation
The Program strongly recommends that weather-resistant barriers (WRB) are repaired/replaced when affected by the installation of wall insulation. Plugs that are located at the sub-siding should be covered with a properly installed WRB after the plugs are sealed. When possible, needed runs of siding should be removed and insulation installed through holes drilled through the sub-siding

Best Practice: Carbon Monoxide
The Program strongly recommends that a carbon monoxide alarm be installed whenever a weatherization measure is performed.

Carbon monoxide alarms should be installed in each bedroom of a house or at minimum within 15 feet of each sleeping area. Contractors should educate their customers on the use of carbon monoxide alarms and precautions that should be taken if the alarm activates. The intention of the alarm is to warn occupants before they experience the symptoms of carbon monoxide poisoning.

Best Practice: Manufactured Homes

All HVAC ductwork, including plenums, shall be repaired, sealed and properly supported, according to section DU before underfloor insulation is installed. Non-ducted return-air systems in the floor cavity shall be eliminated.

Best Practice: Spray-Foam Insulation

Customers should be notified if spray-foam insulation will limit access to electrical services, natural gas lines, HVAC system components or plumbing.

Best Practice: Heating Systems

Existing Homes recommends that heating and cooling systems be sized in accordance with Manual S, Manual D, Manual J, Spec Pro or another industry-accepted HVAC calculation methodology based on building heating loads. The equipment manufacturer's selection procedures and sizing guidelines should be referenced as part of the HVAC planning and sizing process.

Best Practice: Ductless Heat Pumps

Size the unit appropriately to the space to be conditioned; oversized systems negatively impact unit performance.

For optimal performance of the unit, the program recommends using risers between the unit and the permanent pad. Adjustable risers will help prevent debris and snow buildup and allow for better drainage. Riser blocks specifically manufactured/intended for this purpose should be used. The riser blocks should be mechanically or chemically secured to the pad. A pan heater can prevent defrost discharge from freezing inside the compressor and is recommended in extreme climates.

Educate homeowner on filter cleaning and other manufacturer recommended maintenance.

For more information on installation best practices for DHPs, see NW Ductless Heat Pump project's Best Practice Guide: goingductless.com/assets/documents/uploads/DHP_BP-Guide_FNL.pdf.

For additional information on supplementing electric forced air furnaces with ductless heat pumps, see www.bpa.gov/energy/n/emerging_technology/pdf/DHP_FAF_Dec_12.pdf.

Best Practice: Heat Pumps

The Program recommends that the maximum line set length be less than or equal to the manufacturer's specifications, and the line set diameter shall match the manufacturer's recommendations. Line sets should be insulated over their entire length.

The Program recommends that outdoor units be checked for adequate airflow using a TrueFlow Air Handler Flow Meter™.

Strip heat should be set up to not come on in the first stage of operation. Refrigerant charge should be installed in accordance with the manufacturer's specifications. Airflow should be a minimum of 350 CFM per ton.

Best Practice: Heat Pump Water Heaters

If ducting is installed, apply duct insulation and a vapor barrier, or use suitable plastic ducting, to prevent condensation formation on ductwork. If exhaust air only is ducted outside of conditioned space, contractor should ensure combustion appliances are functioning properly and safely and a carbon monoxide alarm should be installed in the home if combustion appliances are present.

Installed ducting should be done to manufacturer's specifications, with manufacturer-approved parts.

Avoid installations near bedrooms or living rooms; if unavoidable, consider using noise dampening features in the space or isolate vibration if noise is a concern. Also consider homeowner comfort impacts of cold air exhaust.

Refer to manufacturer's specifications for efficient mode operation.

Demonstrate filter access and maintenance to homeowner.