Ductless Mini-Split Heat Pumps - Code Compliance Brief

Overview:

The intent of this brief is to provide code-related information about ductless mini-split heat pumps to help ensure that the measure will be accepted as being in compliance with the code. Providing notes for code officials on how to plan review and conduct field inspections can help builders or remodelers with proposed designs and provide jurisdictional officials with information for acceptance. Providing the same information to all interested parties (e.g., code officials, builders, designers, etc.) is expected to resulth in increased compliance and fewer innovations being questioned at the time of plan review and/or field inspection.

Ductless mini-split heat pumps[1] transfer heat to or from a home via the vapor-compression refrigerant cycle (the same mechanism through which conventional, split-system heat pumps work). As their name suggests, ductless heat pumps differ from central-ducted heat pumps in the way they supply conditioned air to a home. Central heat pumps have one indoor coil in an air-handling unit and use forced-air distribution through ductwork to deliver conditioned air to multiple zones within a home. In contrast, ductless heat pumps connect one or more indoor coils (a.k.a., “heads” or “fan coils”) to a single outdoor unit, with each head having its own refrigerant loop.[2] Each head is located in the space that it serves, enabling zonal heating or cooling of the home (i.e., each head has its own thermostat).

By eliminating ductwork, ductless heat pumps avoid the energy losses of central systems with ducts that run through unconditioned attics or crawlspaces. Ductless heat pumps also eliminate the need for a large fan to push air through a system of ductwork. One feature that can save significant energy is that a separate head with its own controls can be installed in each zone, so areas of the house that are vacant can be setback, while comfort is maintained in the areas of the house that are in use. Another energy-saving feature of ductless heat pumps is their inverter-driven compressor, which allows the system to adjust capacity in response to varying loads within the home. Most ductless heat pumps can operate at down to approximately 30% of their rated capacity, thus enabling more efficient operation than single-stage systems that have to start and stop more frequently, which incurs cycling energy losses.

This brief discusses the provisions in the 2015 International Energy Conservation Code (IECC) and International Residential Code (IRC) related to ductless heat pumps. The majority of applicable provisions are those pertaining to HVAC equipment in general or heat pumps in particular. A ductless heat pump’s indoor heads are connected to the outdoor unit by conduits that contain the refrigerant tubing, electrical wiring, and condensate drain tubing. The conduits go through the home’s exterior wall, making code provisions pertaining to wall penetrations applicable.

While most mini-split installations feature wall-mounted or ceiling-mounted heads, an alternative option that most manufacturers offer for homeowners or designers who do not want to see the heads is a ducted mini-split (a.k.a., “concealed-ducted” mini-split). Ducted mini-split installations have a mini-split air handler with short runs of ductwork to one or multiple rooms. For installations involving ducted mini-splits, code provisions pertaining to ductwork are applicable. In this code brief, provisions pertaining only to ducted mini-splits are denoted with an asterisk (*).

Ductless heat pumps can be installed as part of new construction, as a retrofit to provide whole-house space conditioning for an existing home, or as part of an addition/alteration to an existing home. Ductless heat pumps are often used to heat/cool additions to existing homes because they eliminate the need for ductwork to be extended into the addition (as would be required if heating/cooling was to be provided by the existing central system). Ductless heat pumps also can be used in alterations to an existing space (e.g., adding heating/cooling to a space such as a garage that was originally unconditioned). If a ductless heat pump is being installed as part of an addition or alteration to an existing home, code provisions also apply.

[1] Several variations of this term are commonly used, including ductless heat pumps, mini-split heat pumps, ductless mini-splits, mini-splits, and variable refrigerant flow heat pumps.

[2] For diagrams of ductless heat pump installation layouts, indoor heads, and outdoor units, see the “Description” tab of the Building America Guide for Ductless Heat Pumps (**https://basc.pnnl.gov/resource-guides/mini-split-ductless-heat-pumps#block-views-guide-static-blocks-block-2** [1]).

Plan Review:

Per the **2015 IECC/IRC, Section R103.3/R106.3 Examination of documents**. The code official/building official must examine, or cause to be examined, construction documents for code compliance.

This section lists the applicable code requirements and details helpful for plan review regarding the provisions to meet the requirements for "ductless mini-split heat pumps."

Construction Documentation. Review the construction documents to identify the equipment, system controls, and design.

- ***2015 IECC/IRC, Section R103.2/N1101.5 Information on construction documents.*** Construction documents should include:

- Heat pump water heater system design criteria
- Equipment types, sizes and efficiencies
- Equipment and system controls
- Location and installation

- ***Section R302 Design Conditions***
  - ***R302.1 Interior Design Conditions.*** The interior design temperatures used for heating and cooling load calculations shall be a maximum of 72°F (22°C) for heating and minimum of 75°F (24°C) for cooling.

- ***Section R402 Building Thermal Envelope.*** Excerpts from Table R402.4.1.1 Air Barrier and Insulation Installation follow.
  - **Air Barrier Criteria**
    - **Shafts, penetrations.** Ductshafts, utility penetrations, and flue shafts opening to exterior or unconditioned space shall be sealed.
    - **HVAC register boots.** HVAC register boots that penetrate the building thermal envelope shall be sealed to the subfloor or drywall. (This provision only applies to ducted units.)

- ***Section R403 Systems***
  - ***R403.1 Controls (mandatory).*** At least one thermostat shall be provided for each separate heating and cooling system.
    - ***R403.1.1 Programmable Thermostat.*** The thermostat controlling the primary heating or cooling system of the dwelling unit shall be capable of controlling the heating and cooling system on a daily schedule to maintain different temperature set points at different times of the day. This thermostat shall include the capability to set back or temporarily operate the system to maintain zone temperatures down to 55°F (13°C) or up to 85°F (29°C). The thermostat shall initially be programmed by the manufacturer with a heating temperature set point no higher than 70°F (21°C) and a cooling temperature set point no lower than 78°F (26°C).
    - ***R403.1.2 Heat Pump Supplementary Heat (mandatory).*** Heat pumps having supplementary electric-resistance heat shall have controls that, except during defrost, prevent supplemental heat operation when the heat pump compressor can meet the heating load.

- ***Section *R403.3 Ducts.***[3] Ducts and air handlers shall be in accordance with Sections R403.3.1 through R403.3.5.
  - ***R403.3.1 Insulation (prescriptive).*** Supply and return ducts in attics shall be insulated to a minimum of R-8 where 3 inches (76 millimeters) in diameter and greater and R-6 where less than 3 inches (76 millimeters) in diameter. Supply and return ducts in other portions of the building shall be insulated to a minimum of R-6 where 3 inches (76 millimeters) in diameter or greater and R-4.2 where less than 3 inches (76 millimeters) in diameter.

    Exception:

    Ducts or portions thereof located completely inside the building thermal envelope.

- ***R403.3.2 Sealing (mandatory).** Ducts, air handlers, and filter boxes shall be sealed. Joints and seams shall comply with either the International Mechanical Code or IRC, as applicable.

  Exceptions:

  1. Air-impermeable spray foam products shall be permitted to be applied without additional joint seals.
  2. For ducts having a static pressure classification of less than 2 inches of water column (500 Pa), additional closure systems shall not be required for continuously welded joints and seams, and locking-type joints and seams of other than the snap-lock and button-lock types.

  - ***R403.3.2.1, Sealed Air Handler.*** Air handlers shall have a manufacturer's designation for an air leakage of no more than 2% of the design air flow rate when tested in accordance with ASHRAE 193.

- ***R403.3.3, Duct testing (mandatory).** Ducts shall be pressure tested to determine air leakage by one of the following methods:

1. *Rough-in test.* Total leakage shall be measured with a pressure differential of0.1 inch water gage (25 Pa) across the system, including the manufacturer's air handler enclosure if installed at the time of the test. All registers shall be taped of otherwise sealed during the test
2. *Post-construction test.* Total leakage shall be measured with a pressure differential of 0.1 inch water gage (25 Pa) across the entire system, including the manufacturer's air handler enclosure. Registers shall be taped or otherwise sealed during the test.

Exception

A duct air leakage test shall not be required where the ducts and air handlers are located entirely within the building thermal envelope. A written report of the results of the test shall be signed by the party conducting the test and provided to the code official.

- ***R403.3.4, Duct Leakage (prescriptive).*** The total leakage of the ducts, where measured in accordance with Section R403.3.3, shall be as follows:
  1. *Rough-in test.* The total leakage shall be less than or equal to 4 cubic feet per minute (113.3 L/min) per 100 square feet (9.29 m^2) of conditioned floor area where the air handler is installed at the time of the test. Where the air handler is not installed at the time of the test, the total leakage shall be less than or equal to 3 cubic feet per minute (85 L/min) per 100 square feet (9.29 m^2) of conditioned floor area.
  2. *Post-Construction test.* Total leakage shall be less than or equal to 4 cubic feet per minute (113.3 L/min) per 100 square feet (9.29 m^2) of conditioned floor area.
- ***R403.3.5, Building Cavities (mandatory).*** Building framing cavities shall not be used as ducts or plenums.
- ***R403.7, Equipment Sizing and Efficiency Rating (mandatory).*** Heating and cooling equipment shall be sized in accordance with Air Conditioning Contractors of America (ACCA) Manual S based on building loads calculated in accordance with ACCA Manual J or other approved heating and cooling calculation methodologies. New or replacement heating and cooling equipment shall have an efficiency rating equal to or greater than the minimum required by federal law for the geographic location where the equipment is installed.
- ***Section R405, Simulated Performance Alternative (performance)***

Excerpts from Table R405.5.2(1) Specifications for the Standard Reference and Proposed Designs

Building Component	Standard Reference Design	Proposed Design
Heating Systems [a,b]	As proposed for other than electric heating without a heat pump, where the proposed design utilizes electric heating without a heat pump the standard reference design shall be an air source heat pump meeting the requirements of Section C403 of the IECC-Commercial Provisions. Capacity: sized in accordance with Section R403.7.	As proposed
Cooling Systems [a,c]	As proposed Capacity: sized in accordance with Section R403.7.	As proposed
*Thermal Distribution Systems	*Duct insulation: From Section R403.3.1 *A thermal distribution system efficiency (DSE) of 0.88 shall be applied to both the heating and cooling system efficiencies for all systems other than tested duct systems. For tested duct systems, the leakage rate shall be 4 cfm (113.3 L/min) per 100 ft2 (9.29 m2) of conditioned floor area at a pressure differential of 0.1 inches w.g. (25 Pa).	*As tested or as specified in Table R405.5.2(2) if not tested. Duct insulation shall be as proposed.
Thermostat	Type: Manual, cooling temperature setpoint = 75°F; Heating temperature setpoint = 72°F	Same as standard reference.

[a] For a proposed design with multiple heating, cooling, or water heating systems using different fuel types, the applicable standard reference design system capacities and fuel types shall be weighted in accordance with their respective loads as calculated by accepted engineering practice for each equipment and fuel type present.

[b] For a proposed design without a proposed heating system, a heating system with the prevailing federal minimum efficiency shall be assumed for both the standard reference design and proposed design.

[c] For a proposed design home without a proposed cooling system, an electric air conditioner with the prevailing federal minimum efficiency shall be assumed for both the standard reference design and the proposed design.

Excerpts from Table R405.5.2(2) Default Distribution System Efficiencies for Proposed Designs

DISTRIBUTION SYSTEM CONFIGURATION AND CONDITION	FORCED AIR SYSTEMS

DISTRIBUTION SYSTEM COMPONENTS LOCATED IN UNCONDITIONED SPACE	-
UNTESTED DISTRIBUTION SYSTEMS ENTIRELY LOCATED IN CONDITIONED SPACE[B]	0.88
"DUCTLESS" SYSTEMS[C]	1
[A] DEFAULT VALUES GIVEN BY THIS TABLE ARE FOR UNTESTED DISTRIBUTION SYSTEMS, WHICH MUST STILL MEET MINIMUM REQUIREMENTS FOR DUCT SYSTEM INSULATION. [B] ENTIRE SYSTEM IN CONDITIONED SPACE SHALL MEAN THAT NO COMPONENT OF THE DISTRIBUTION SYSTEM, INCLUDING THE AIR-HANDLER UNIT, IS LOCATED OUTSIDE OF THE CONDITIONED SPACE. [C] DUCTLESS SYSTEMS SHALL BE ALLOWED TO HAVE FORCED AIRFLOW ACROSS A COIL BUT SHALL NOT HAVE ANY DUCTED AIRFLOW EXTERNAL TO THE MANUFACTURER'S AIR-HANDLER ENCLOSURE.	

- ***Section R502, Additions***
  - ***R502.1.1.2 Heating and cooling systems.*** New heating, cooling, and duct systems that are part of the addition shall comply with Sections R403.1, R403.2, R403.3, R403.5, and R403.6. (Sections R403.2, R403.5, and R403.6 deal with hot water boilers, service hot water systems, and mechanical ventilation, respectively. Because these sections do not directly pertain to ductless heat pumps, they are not listed in this Code Brief.)
- ***Section R503, Alterations***
  - ***R503.1.2, Heating and Cooling Systems.*** New heating, cooling, and duct systems that are part of the alteration shall comply with Sections R403.1, R403.2, R403.3, and R403.6. (Sections R403.2 and R403.6 deal with hot water boilers and mechanical ventilation, respectively. Because these sections do not directly pertain to ductless heat pumps, they are not listed in this Code Brief.)
  - ***R503.2, Change in Space Conditioning.*** Any non-conditioned or low-energy space that is altered to become conditioned space shall be required to be brought into full compliance with this code.

Exception

Where the simulated performance option in Section R405 is used to comply with this section, the annual energy cost of the proposed design is permitted to be 110% of the annual energy cost otherwise allowed by Section R405.3.

2012 IRC

- ***Section M1403 Heat Pump Equipment***
  - ***M1403.1, Heat Pumps.*** The minimum unobstructed total area of the outside and return air ducts or openings to a heat pump shall be not less than 6 square inches per 1,000 Btu/h (13,208 square millimeters per kilowatt) output rating or as indicated by the conditions of the listing of the heat pump. Electric heat pumps shall conform to UL Standard 1995, Heating and Cooling Equipment.[4] (2015 IRC, Section M1403.1 Heat Pumps. Electric heat pumps shall be listed and labeled in accordance with UL 1995 or UL/CSA/ANCE 60335-2-40.)
  - ***M1403.2, Foundations and Supports.*** Supports and foundations for the outdoor unit of a heat pump shall be raised at least 3 inches (76 millimeters) above the ground to permit free drainage of defrost water, and shall conform to the manufacturer's installation instructions.
- ***Section M1411 Heating and Cooling Equipment***
  - ***M1411.1 Approved Refrigerants.*** Refrigerants used in direct refrigerating systems shall conform to the applicable provisions of ANSI/ASHRAE 34.
  - ***M1411.3, Condensate Disposal.*** Condensate from all cooling coils or evaporators shall be conveyed from the drain pan outlet to an approved place of disposal. Such piping shall maintain a minimum horizontal slope in the direction of discharge of not less than ? unit vertical in 12 units horizontal (1% slope). Condensate shall not discharge into a street, alley, or other areas where it would cause a nuisance.

  For additional information regarding condensate pumps, auxiliary and secondary drain systems, water-level monitoring devices, and drain pipe materials and sizes, see the full 2012 or 2015 IRC.
  - ***M1411.5, Insulation of Refrigerant Piping.*** Piping and fittings for refrigerant vapor (suction) lines shall be insulated with insulation having a thermal resistivity of at least R-4 and having external surface permeance not exceeding 0.05 perm[5] when tested in accordance with ASTM E 96.
  - ***M1411.6, Locking Access Port Caps.*** Refrigerant circuit access ports located outdoors shall be fitted with locking-type tamper-resistant caps or shall be otherwise secured to prevent unauthorized access.

[3] As mentioned previously in this brief, provisions pertaining only to ducted mini-splits are denoted with an asterisk (*).

[4] http://ulstandards.ul.com/standard/?id=1995&edition=4&doctype=ulcsa [2]

[5] 2.87 ng/(s×m2×Pa)

Field Inspection:

Per the ***2015 IECC, Section R104 Inspections.*** Construction or work for which a permit is required is subject to inspection. Construction or work is to remain accessible and exposed for inspection purposes until approved. Required inspections include footing and foundation, framing and rough-in, plumbing rough-in, mechanical rough-in, and final inspection.

- ***R104.2.4, Mechanical Rough-In Inspection***. Inspections at mechanical rough-in shall verify compliance as required by the code and approved plans and specifications as to installed HVAC equipment type and size, required controls, system insulation and corresponding R-value, system air leakage control, programmable thermostats, dampers, whole-house ventilation, and minimum fan efficiency.

Per the ***2015 IRC, Section R109 Inspections.*** The wording is somewhat different in that for onsite construction, from time to time the building official, upon notification from the permit holder or his agent, can make, or cause to be made, any necessary inspections. Further details are provided for inspections regarding foundation, plumbing, mechanical, gas and electrical, floodplain, frame and masonry, and final inspection. Any additional inspections are at the discretion of the building official.

This section provides details for inspecting to the specific provisions for ductless mini-split heat pumps where one or more specific type of inspection per the IECC or IRC may be necessary to confirm compliance. Verifying code compliance for ductless mini-split heat pumps would typically be at the mechanical rough-in and final inspection.

Inspections should provide verification in the following areas:

- Ductless mini-split heat pump is properly labeled, located and mounted, and connections are made per approved construction documents.
- Verification that appropriate programmable thermostats and supplemental heat controls are installed per the approved construction document.
- Batt insulation should be cut neatly to fit around wiring and plumbing in exterior walls, or insulation that readily conforms to available space on installation should extend behind piping and wiring.
- If ducts are used in the installation, verify that joints and seams in ductwork are properly sealed, and the duct tightness report is complete and has been submitted per jurisdictional requirements. If ducts are employed, duct insulation is installed in accordance with manufacturer's installation instructions, the manufacturer's R-value mark is readily available, and meets the approved R-value per construction documents.
- Foundations and supports for outdoor unit meet manufacture installation instructions
- Condensate pumps meet the approved construction documents and manufacturer installation instructions.
- Condensate disposal, auxiliary and secondary drain systems, water-level monitoring devices, and drain pipe material and sizes meet the approved construction documents and manufacturer installation instructions.
- Refrigerant piping is properly insulated and meets the approved R-value per construction documents.
- Outdoor refrigerant circuit access ports are fitted with a locking-type tamper-resistant cap or secured to prevent unauthorized access.

Technical Validation(s):

This section provides additional information and helpful resources.

- Building America Guide for Ductless Heat Pumps: **https://basc.pnnl.gov/resource-guides/mini-split-ductless-heat-pumps** [3]
- ACCA Manual D – Residential Duct Systems, Air Conditioning Contractors of America, 2013. **https://www.acca.org/technical-manual/manual-d/** [4]
- ACCA Manual J – Residential Load Calculation, Air Conditioning Contractors of America, 2011. **http://www.acca.org/technical-manual/manual-j/** [5]
- ACCA Manual S – Residential Equipment Selection, Air Conditioning Contractors of America, 2013. **http://www.acca.org/technical-manual/manual-s/** [6]