

AIR-SOURCE HEAT PUMP BEST PRACTICES INSTALLATION GUIDE



INTRODUCTION

Proper installation of an air source heat pump (ASHP) system is necessary to ensure customer satisfaction and efficient operation. Optimal performance in colder temperatures provides customers with increased comfort and value, reducing callbacks and generating referrals for increased sales. Recent adopters have reported purchasing an ASHP after experiencing this type of system at the home of a friend or neighbor. This guide outlines best installation practices, provides tips to prevent common installation issues, and is designed to help ensure customers are satisfied and heat pumps are operating efficiently in our cold climate. For additional resources and guidance on equipment selection, system sizing and proper design, see our online toolbox at slipstreaminc.org/ComEd-ASHP.

Heat pumps should always be installed by a licensed, trained professional. All manufacturer specification and installation instructions should be followed, in addition to any applicable HVAC, electrical, and plumbing regulations or building codes. It is strongly recommended that installers attend a manufacturer training or preferred installer program and stay up to date on installation procedures for current and new-to-market equipment.

ASHPs come in a variety of styles and configurations, making them a customizable solution for most homes and businesses.

ASHP capabilities can often be identified by compressor type. Single and two or three stage systems are most commonly found as centrally ducted systems and can provide cooling and heating as low as 25 degrees Fahrenheit, depending on current home fuel type. Variable speed or inverter based systems offer the highest efficiency and cold climate performance, with some operating at temperatures as low as 15 degrees below zero. ASHPs may be single or multi zone:

- » Single zone systems have one outdoor unit with one indoor unit
- » Multi-zone systems have a minimum of two indoor units with one outdoor unit.

Various terms are used to identify different types of heat pumps. These guidelines will focus on the configuration categories and use icons to indicate if guidance is specific to a certain system type:



Ductless ASHP: any non-ducted indoor unit (includes wall-mount air handlers, floor mounted consoles and in-ceiling cassettes).



Compact-ducted ASHP: small air handlers typically designed for compact, concealed-ceiling, or short-duct configurations (aka “pancake units” and mixed ducted/ductless).



Centrally-ducted ASHP: whole-house systems with central air handlers (or furnaces), either single-stage or inverter-driven.

INSTALLATION REQUIREMENTS AND BEST PRACTICES

LINE SET

- » Follow manufacturer's instructions for minimum and maximum line set length and height change:
 - Multi-zone systems have minimum and maximum pipe lengths and height change requirements between each indoor unit.
- » Line set must meet the manufacturer specifications for the indoor unit*. Adapters to increase pipe size should be made at the connections to the outdoor unit to prevent reduced capacity and efficiency.
- » Insulation must cover the entire length* (both pipes) to avoid condensation and energy loss. Once insulated, the outdoor portion should be protected with a rigid cover to prevent damage to insulation.
- » Penetrations through the building enclosure must be rodent proof (e.g., PVC sleeve and cap drilled to the size of the line set, metal-wool stuffing, or similar.)
- » UV-resistant tape or other mechanical protection should be used as needed to protect any remaining exposed insulation. UV-protected insulation products meet this requirement.
- » All shell penetrations should be sealed with insulating sealant/spray foam. Any aspects of insulation disturbed by the install should be returned to proper condition.
- » Prevent partial kinks in line sets*. Partial kinks significantly impact heat pump reliability and performance in cold temperatures. Kinked sections are also likely to become the source of leaks.
 - Remove line set covers.
 - Operate in the most powerful mode so it heats at full capacity.
 - Feel along the entire length of the line set for hot spots, indicating where a partial kink is located.



Figure 1 Insulate and tape flare nuts to prevent cracks due to frost formation.



Figure 2 Air seal and waterproof wall penetrations.

REQUIRED TOOLS



Flaring tool



Programmable refrigerant charging scale



Digital torque wrench



Vacuum pump



Gauge & hose set for each refrigerant type serviced

* Guidelines with an asterisk indicate elements that—if installed incorrectly—can increase the system's energy consumption.

REFRIGERANT TUBING

- » Remove all burrs from the cut pipe and take care to prevent shavings from collecting in pipe.
- » Skills check: Create new flare fittings using a ratchet or orbital flaring tool (some flare tools have a built-in stop) and measurement gauge appropriate to the refrigerant and in accordance with manufacturer's instructions. Only compatible refrigerant oil should be applied to the end of each flare. Practice flare fittings with scrap pipe to reduce the potential for the flare to become a primary source of leaks.
- » Connect tubing with the appropriate nuts (supplied by manufacturer) and program torque within manufacturer specifications. Do not over tighten.
- » DO NOT REUSE the flares and fittings from the linesets provided by a third party vendor.
 - Installer should use the fittings that come with the equipment.
 - Cut off the existing flare and use the nut that comes with the product and re-flare the line.
- » Chicago note: Complete any brazed connections with dry nitrogen to prevent oxidation.
- » Best practice: Avoid using flare fittings except when necessary. It is recommended that connections are made using gasketed press/crimp designed for the refrigerant and tubing type (e.g. Zoom Lock®, LokRing®, RLS®). This type of fitting has the shortest assembly time, the lowest assembly failure rate and is considered most durable.

REFRIGERANT CHARGE

- » Pressure test the line set with dry nitrogen and complete a triple vacuum pump per manufacturer's instructions.
- » Vacuum should be held at 500 microns or less for a minimum of 15 minutes in each of the three vacuum cycles, and then valved off to check for pressure changes that could indicate contamination or leaks.
- » Each evacuation should be alternated with nitrogen under pressure.
- » Only test refrigerant lines at pressures lower than the rating of service valves per manufacturer's instructions.
- » Charge should be adjusted ONLY IF NECESSARY – many installations do not require adjustment from pre-charge levels with standard line set.
- » Follow manufacturer's instructions for adjusting refrigerant when using a nonstandard line set length. Consult the current manufacturer installation manual or design tools to verify refrigerant protocol. Always follow proper procedures for refrigerant handling, including use of a scale to weigh charge.

CONDENSATE DRAIN

- » Slope drain downhill. If routed with line set, select a suitable termination away from foundations, walkways and outdoor equipment.
- » Alternately, use external condensate pumps when necessary.
- » Ductless systems have limited horizontal and vertical lift built in. Do not exceed the manufacturer's specifications for allowable vertical lift before a continuous downward slope.



OUTDOOR UNIT INSTALLATION

- » **Free flow of air is a must.** Follow manufacturer clearance requirements from obstructions, this includes walls, overhangs, protrusions, other outdoor units, etc. Ensure outdoor units do not obstruct windows or doors.
 - Install outdoor units in locations protected from oncoming wind if possible. Strong winds may affect fan operation and, when combined with precipitation, can cause ice to form. Install a wind baffle from the equipment manufacturer.
- » **Location of outdoor units must be approved by the customer** and follow local noise and property line setback ordinances. For aesthetic and sound considerations, select an inconspicuous location (e.g., rear or side of building) or recommend variable speed equipment for reduced noise pollution. Placement concerns to discuss with homeowner/areas to be avoided:
 - Occupied bedrooms and other quiet spaces.
 - Walkways or other areas where freezing defrost meltwater could cause a slip-and-fall hazard.
 - Drip lines from the roof or other overhang (if this cannot be avoided, add a drip cap or shield approved by the manufacturer).
- » **Multiple units should not be installed above each other** or with an outdoor fan outlet flow pointing directly at another unit (except when explicitly recommended by the manufacturer).
- » **Ensure adequate clearance above historical average maximum snow depth** (typically 12 inches is sufficient). Outdoor units should be secured to a pad, risers, or the surface they sit on using factory-approved stands and bolts or adhesives. Ensure that a ground-mounted unit is on well-drained soil and will not heave with frost. Units should be level, both side-to-side and front-to-back. **Best practice:** Use wall brackets designed for attachment to foundation wall when ground clearance allows.
 - Wall mount brackets designed for attachment to wood frame construction may also be used. 2x6 construction is suggested.
 - Use vibration absorbers (rubber feet) to prevent noise transfer.
- » **Best practice:** Install surge suppressors at service disconnect to protect sensitive electronics. Suppressors are also available for installation in electrical panel, if device is approved for such application. Follow manufacturer's instructions and all applicable codes and standards.
- » **Best practice:** Drain pan heaters are strongly recommended for cold climate ASHPs operating in below freezing temperatures.



Figure 3 Proper placement: On brackets, insulated tubing, rigid line cover and drip cap.



Figure 4 Proper placement: Away from drip line, on stand, with wind baffle and insulated line set.

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PLACEMENT OF INDOOR UNITS

- » Indoor, wall-mounted units must be installed with adequate clearance from the ceiling*. Always maintain top clearance for ductless units as required by manufacturer's instructions, and wherever possible, provide additional clearance from the ceiling (six inches minimum). In basements with exposed floor joists, maintain six inches below bottom of joist for heights up to eight feet. In rooms with higher or vaulted ceilings, units should be installed so discharge air is no higher than eight feet from the floor.
- » Best practice: Install floor-mounted units or compact-ducted systems with floor registers, especially in large living areas and lower levels of two-story homes. Floor-based units provide heat where it is needed and occupants are less likely to report feeling cold air.



WIRING

Power should always come from an exclusive branched circuit. Mini/multi split indoor units are powered by the outdoor unit from terminals one and two, with control typically on three. Carefully read and follow manufacturer wiring directions and be sure to connect indoor units to the correct terminal block at the outdoor unit. Miswiring will result in damage to equipment.

- » Code may require a disconnect at the indoor unit, due to high voltage wiring.
 - Consult installation manuals frequently and verify wiring against circuit diagram on outdoor unit. At indoor unit, match the terminal block numbers and connection cable colors with those of the outdoor unit.
- » Ensure screws are securely fastened at terminal blocks and crimps are secure, if used.
- » Ground (aka earth wire) must be separate and should be longer than common wires to accommodate the independent terminal at indoor unit.



DUCTING






- » Design ductwork to minimize friction losses*. Close attention should be paid to available static pressure, especially with compact-ducted air handlers (many of which are considered low static, compared to typical air handlers). Refer to ACCA Manual D for duct design guidance and manufacturer specifications.
- » Best practice: Factory default conditions are typically the lowest external static pressure (ESP) possible. Refer to manufacturer specifications for the indoor unit for direction on setting external static pressure.
 - If ESP is too low, customers may experience inconsistent comfort levels.
- » Avoid installing new ducts in unconditioned space, when possible. For ducts and air handlers in unconditioned spaces, all joints and seams in ductwork must be thoroughly sealed with mastic and all components insulated to a minimum of R-8.
 - Best practice: For ducts in unconditioned space, encapsulate ducts in closed-cell spray foam.
- » When installing central ASHP systems using existing ducts, always ensure ductwork is adequately sized for the heat pump air flow requirements and available static pressure. This may result in sizing the heat pump for only supplemental/partial heat.



* Guidelines with an asterisk indicate elements that—if installed incorrectly—can increase the system's energy consumption.





SYSTEM SETUP

THERMOSTAT – INSTALLER SETUP

- » Ensure a compatible thermostat is installed with ASHP. High-end, inverter-based heat pumps from major manufacturers perform best with the proprietary communicating thermostat. If communicating equipment is specified, be sure the correct thermostat is included for proper operation of variable capacity systems. 
- » For spaces of 300 square feet or more, a fixed, wall-mount control is recommended and should be installed in a location representative of the space it is serving. Configure so the temperature is sensed at the thermostat rather than the air handler. Return air temperature sensing controlled by handheld remote is acceptable in smaller rooms and isolated zones with no significant thermal/comfort problems. 
 - Be sure the thermostat is not in the direct path of air from another air handler.
 - Wireless thermostats may require unobstructed line of sight for proper operation.
- » Temperature-sensing adjustment, especially for high wall-mounted indoor units: Adjusting the offset temperature two to four degrees is often necessary to provide more heating and less cooling, typical for situations where air distribution may be compromised. Further adjustment may be required based on occupant comfort or actual room temperature. 
- » For setups with heat pumps plus a central HVAC system, use an integrated, multi-stage control when available (e.g., boiler with mini splits, central furnace with poor ductwork and mini split for A/C). If not, advise the customer on the use of two thermostats. Temperature settings on either thermostat can be adjusted to reduce backup heat, depending on customer need. 
 - Best practice: Regardless of the use of integrated control, consider installing an outdoor cut-out control on the central system to prevent operation when the outdoor temperature is above cut-out temperature (Set cutout between 20 and 35F, and adjust as needed for occupant comfort or energy savings).

CONTROL SETTINGS - INSTALLER CONTROLS

Check installer settings as needed. Some highlights are below:

- » Retain installer settings during power outage.
- » Some compact, low static, ducted air handlers require selection of static pressure. 
- » If available, use installer settings to prevent continuous fan operation even at low speed. 
- » Poor crimps and splices are a common cause for communication and power error codes on startup. 
 - Ensure ground wire is connected at outdoor unit.
 - Check for errors in wiring by running a temporary wire from indoor to outdoor unit through window or door.
- » For all electric central systems, lock out electric heat strips, except at defrost and below thermal balance point of heat pump. 

HOMEOWNER EDUCATION

- » Demonstrate the basic controls and operation to homeowners.
 - For mini splits, run customers through heating and cooling mode operation and explain how to set temperature.
 - For central ASHP with gas backup, inform the customer of the switch-over temperature set and how to override/switch to backup heat.
- » Set expectations to reduce calls for no heat/cold blow.
 - Operate in heating mode and have homeowner acknowledge the cooler temperature.
 - During this operation explain to the customer that it will take longer to increase the temperature compared to a furnace or boiler. It may be an hour or two, compared to minutes, as the heat produced is of lower temperature. To ensure customer comfort suggest a limited setback no more than three degrees.
- » Review maintenance tasks to be completed by homeowner and when to call for manufacturer-recommended maintenance.
- » Provide homeowner with manufacturer's operation/owner's manuals for the ASHP and the installed thermostat.



ADDITIONAL RESOURCES

- » U.S Department of Energy Building America Solution Center (HVAC-Heating Equipment) – <https://basc.pnnl.gov/>
- » ENERGY STAR Verified HVAC Installation (ESVI) Program – https://www.energystar.gov/https%3A//www.energystar.gov/campaign/heating_cooling/esvi
- » ACCA Standard 5 (ANSI/ACCA 5 Q1-2015); HVAC Quality Installation Specification – <https://www.acca.org/standards/quality>

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