Installation Guide

Air Source Heat Pumps Best Practices Installation Guide

Introduction

High quality installation of air source heat pumps (ASHPs) improves system performance and efficiency, optimizing operational economics and heating down to colder temperatures. This performance improvement can ensure customer satisfaction and comfort, which in turn reduces callbacks, generates referrals, and increases sales. This guide outlines the best practices for all ASHP installations, as well as guidance on homeowner education to help keep customers happy.

Heat pumps should always be installed by licensed, trained professionals. Always follow the manufacturer's specifications and installation instructions, as well as all applicable building codes and regulations. All installers should attend a manufacturer's training or preferred installer program.

Installation Requirements and Best Practices

Line Set

- Installers should follow the manufacturer's instructions for minimum and maximum line set length and height change. Line set must meet the manufacturer's specification for the indoor unit — adaptations to the outdoor portion can be made if necessary. Ensure pipes are properly insulated based on where the metering device is located.

  > For mini-split systems, the metering device is generally in the outdoor unit, so both the liquid and vapor lines should be insulated.

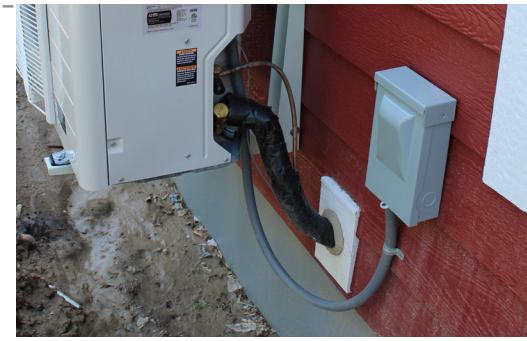
  > With centrally ducted systems, the metering device is generally inside the home, so the liquid line does not need to be insulated in these applications unless specified by the manufacturer. Once insulated, the outdoor portion of the line set should be protected with a rigid cover to avoid insulation damage.

- UV-resistant tape or other mechanical protection should be installed as needed to protect any remaining exposed insulation. UV-protected insulation products meet this requirement.

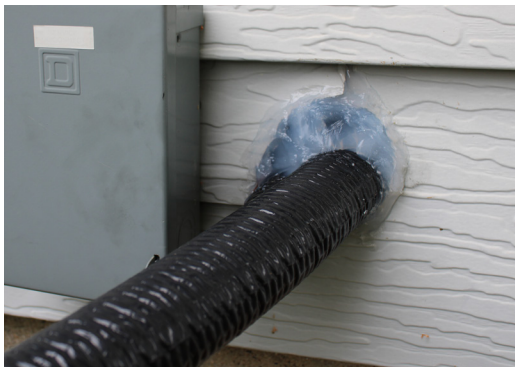
- Line set penetration through the building enclosure should be protected from rodents (e.g., with a PVC sleeve and cap drilled to the size of the refrigerant lines, metal-wool stuffing, or similar).

- All penetrations through the shell of the home should be sealed with insulating sealant/spray foam. Any aspects of the insulation disturbed by installed line set should be returned to proper condition.

- Prevent partial kinks in line sets. Partial kinks can cause significant



Ensure that the insulation is thorough and covers the entire line set, as shown here.



Be sure to air seal all wall penetrations.

impact to heat pump reliability and performance in cold temperatures. Kinks typically occur in line sets that are greater than or equal to 7/8" in diameter. Follow these steps to check for partial kinks:

1. Remove line set covers.
2. Set the machine to its most powerful mode so it heats at full capacity.
3. Feel along the entire length of the line set for hot spots, which indicate where any partial kinks are located.

Refrigerant Tubing

- Create new flare fittings using a ratcheting flaring tool and measurement gauge appropriate to the refrigerant and in accordance with the manufacturer's instructions. Apply refrigerant oil to the end of each mated flare surface.
- Connect tubing with the appropriate nuts (supplied by manufacturer) and tighten to the manufacturer's torque specifications.
- **DO NOT** use tubing and flare fittings that were not provided by the manufacturer.
- Once used, **DO NOT REUSE** manufacturer-provided tubing flares and fittings.
- Any brazed connections should be completed with dry nitrogen to prevent oxidation.

Refrigerant Charge

- Pressure test the line set using dry nitrogen and triple evacuation per manufacturer's instructions.
- Perform a triple evacuation by purging and pressuring with nitrogen in between the three vacuum pump evacuation cycles. Valve off the system in between to ensure a dry and tight refrigeration system. The final vacuum should be held at less than 500 microns for a minimum of 10 minutes. Refer to the specific manufacturer installation instructions for more details.
- Test refrigerant lines using dry nitrogen at the maximum allowed pressures per the manufacturer's specifications (typically 500 – 600 PSI).
- Refrigerant charge should be adjusted ONLY IF NECESSARY — many installations do not require adjustment from pre-charge levels with standard line set.

Carefully follow the manufacturer's recommendations for adjusting refrigerant charge when using any nonstandard line set length. Consult the current manufacturer installation manual and/or software design tools to verify refrigerant protocols. Always follow proper procedures for weighing and recovering refrigerants. Always use a scale when adding or removing refrigerant.

Condensate Drain

- The drain should slope downhill. It can be routed with line set and run to a suitable termination point — away from crawl spaces, walkways, and outdoor equipment.
- Alternately, use an external condensate pump when required.
- Ductless systems may have limited horizontal or vertical lift built in. Do not exceed the manufacturer's specifications for allowable vertical lift before a continuous downward slope.

Outdoor Unit Installation

- Outdoor units should be placed to allow for free air flow. Follow manufacturer's guidance on clearance from obstructions, including walls, overhangs, protrusions, and other features. Ensure that outdoor units do not interfere with windows or doors.

  > Install outdoor units in a location protected from the wind if possible. Wind chill can affect heat pump performance, and facing into the wind can push freezing rain or snow into the system. If this cannot be avoided, install a wind baffle from the manufacturer to protect the system.

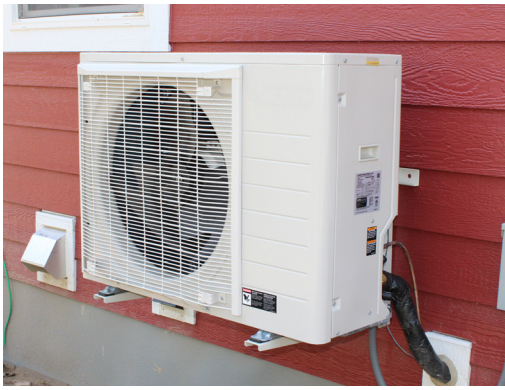
- The customer should always approve the location of outdoor units. The units should be located in inconspicuous places for aesthetic and noise considerations (e.g., behind the building).

  > Locate outdoor units away from bedrooms and other quiet spaces.

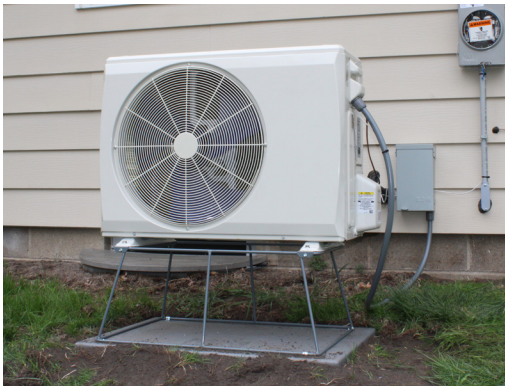
- Follow manufacturer-allowed clearances when placing multiple units. Multiple units should not be installed above each other or with outdoor fan outlet flow pointing directly at another unit (except when explicitly recommended by manufacturer).
- Ensure adequate clearance above historical average maximum snow depth, typically 14" in Minnesota. Secure outdoor units to a pad, risers, or the surface they sit on using a factory-approved stand and bolts or adhesive. The outdoor unit 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.

  > Installations can also use wall mounts or brackets designed for attachment to foundation wall. In these cases, use double-ended vibration absorbers to prevent both noise transfer through the wall and premature failure of the attachments.

- Avoid proximity to walkways or other areas where re-freezing defrost meltwater might cause a slip-and-fall hazard.



Proper placement: on brackets, insulated tubing, rigid line cover, wind baffle.



Equipment stand: keeping the unit above the snow (to some degree).

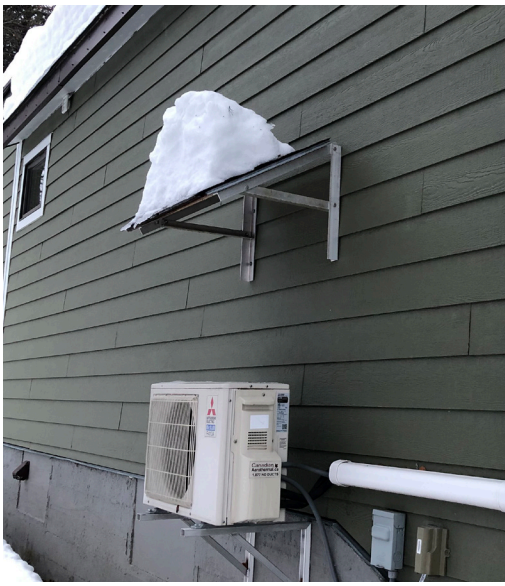
- When possible, avoid installing outdoor units directly under any drip line from the roof or other overhang that would subject them to falling snowmelt, ice, or concentrated rain runoff.

  > 3 – 6 inches of clearance from a drip line is typically recommended – the unit should be protected from runoff, but it also shouldn't be placed too far out from the building. This distance can be increased when outdoor space is less limited – more clearance is recommended when there is higher risk of accumulated snow sliding off the roof (e.g., metal roof with no gutter).

  > When this is unavoidable, and a functioning gutter is not present, outdoor units should be installed with drip caps or shields approved by the manufacturer.

- Install surge suppressors at service disconnect to protect sensitive electronics. Alternatively, suppressors may be installed at circuit breaker box if device is approved for such application. Follow the manufacturer's instructions and all applicable codes and standards.

- Drain pan heaters are strongly recommended for cold-climate ASHPs that operate below 32 degrees Fahrenheit. These are not generally needed for non-cold-climate systems in situations where meltwater clearance and protection from precipitation are adequate.



Proper outdoor placement, showcasing a drip cap/snow shield.

Controls Strategies

Switchover Temperature Selection

A switchover temperature is a defined outdoor ambient temperature at which the heat pump should no longer be used for heating, turning on the supplemental heat system to supply the heating load.

Switchover Temperature = Balance Point = Compressor Lockout *

*For some controls/thermostats, both a switchover temperature and a separate compressor lockout are available. For other brands, the compressor lockout is used as the switchover temperature.

The switchover temperature can be selected based on the capacity and economic balance points of the system. It's important to ensure that the switchover temperature is not set below the capacity balance point without additional protective controls strategies, such as a droop setting described in the next section below. While it's recommended to take advantage of operational cost savings, homeowner comfort should always be the top priority.

Balance Point Definitions

Balance Point Type	Definition
Capacity Balance Point	The outdoor temperature at which the heat pump can no longer produce the heating capacity needed for the home. Also called the Thermal Balance Point.
Economic Balance Point	The outdoor temperature at which the cost to heat the home with the heat pump is the same or more expense than the auxiliary heat cost. Depends on both the primary and auxiliary heat fuel costs.*

*The economic balance point for a propane auxiliary heat system is typically much lower than that of a natural gas auxiliary heat system. To calculate the economic balance point, please refer to the formula included in the Controls Guide for Contractors.

Other Controls Strategies

In addition to selecting a switchover temperature, it is recommended to implement other controls strategies to ensure homeowner comfort and optimize potential cost savings. For dual fuel systems, it is recommended to implement a droop setting. Droop is a specified temperature value that defines the maximum allowable temperature swing below the heating setpoint before auxiliary heat is engaged. This temperature can generally be set between 1°F and 5°F. Maximizing the droop temperature will result in higher efficiency, while minimizing the droop temperature will improve comfort. 2°F is typically recommended for colder climates, but it is recommended to understand the homeowner's priorities to select the best droop temperature for each installation.

General Considerations & Tips

- Make sure values are consistent through all parts of the load calculation and sizing/design processes.
- Use the same temperatures for both load calculations and sizing design (Manual J and Manual S or equivalents).
  - This is easier if you're using the same tool and pulling the same data.
  - If using separate tools, you need to be aware of the need for consistency and ensure inputs are the same.

Homeowner Education

- Provide a copy of the manufacturer's owner manual to the homeowner
- Take the time to demonstrate basic controls and operations to homeowners. Review maintenance schedule and other activities with them.
- Important topics to discuss when switching from an AC to a Heat Pump:
  - Register temperatures
    - Heat pumps blow 'warm' air as opposed to furnaces blowing 'hot' air
    - Ensure the homeowner understands this change and see if there are any opportunities to modify supply air flow so that the temperature difference doesn't cause discomfort.

Switchover temperature and heat pump interaction with supplemental heat

- Help the homeowner understand when they can expect the heat pump to run and when they can expect the furnace to run.

Thermostat settings

- Deep setbacks are a common strategy used by homeowners to save on operational costs with an AC + Furnace system.
- Recommend that the homeowner use shallow setbacks (if at all) ; heat pumps operate more effectively and efficiently during longer run times.

Defrost cycle

- Make sure the homeowner understands that the heat pump will occasionally go into defrost mode, and that the outdoor unit may make more noise and release steam during this operation.
- If outdoor conditions allow, it can be helpful to show them what a defrost cycle looks and sounds like after the installation is complete. Otherwise, it's recommended to have a video of a defrost cycle available to show the homeowner what to expect.

Maintenance – Snow Removal

- In addition to standard maintenance practices that are common between ACs and heat pumps, it's critical that the homeowner understand the importance of snow removal.
- For the heat pump to continue operating effectively, snow needs to be removed from the area around the outdoor unit to not inhibit airflow.

Utility bill changes

- While overall utility bills will either stay the same or decrease depending on fuel type and rates, ensure that the homeowner understands that their electric cost will increase and that their natural gas or propane costs will decrease.

Additional Resources

- U.S. Department of Energy Building America Solution Center (HVAC-Heating Equipment) — basc.pnnl.gov
- ACCA Standard 5 (ANSI/ACCA 5 QI-2015); HVAC Quality Installation Specification Acca.org/standards/quality
- NEEP Cold Climate Air Source Heat Pump List – Advanced Sizing for Heating Tool ashp.neep.org/#!/

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ASHP air source heat pump collaborative