Air-Source Heat Pumps without Callbacks

Jon Harrod
Learning objectives

- List steps involved in designing and installing air source heat pumps
- Describe best practices for design, installation, and maintenance
- Avoid and troubleshoot common installation issues
- Become familiar with Northeast Energy Efficiency Partnerships (NEEP) Cold Climate Air Source Heat Pump resources
Cold-climate air-source heat pumps

- Flexible
- Efficient in heating and cooling
- Cost-effective
- Simple to install
- Scalable
- Low-carbon
Yes, but...

*These systems can be unforgiving when it comes to poor design and workmanship.*

- Poor temperature control
- Excessive noise
- Inefficient operation
- Multiple callbacks
- Short lifespan

*What should we do to ensure good results? What shouldn’t we do?*
Most problems with cold climate heat pumps are due to contractor error

- Application (design & specification)
- Installation
- Operation & maintenance
Introduction
High-quality installations of air-source heat pumps can help improve customer comfort and efficiency and performance of an ASHP system in recent years. This guide provides homeowner education and system setup guidance for customers in cold climates.

Heat pumps should always be installed by an experienced technician or manufacturer's representative to ensure proper operation and efficiency. ASHP systems come in a variety of configurations and types. There are many variations, and terraced models include "ductless ASHP" or "compact-ducted ASHP" configurations or short-duct designs.

ASHPs can be installed in a variety of ways, including:
- Ductless systems
- Full installations
- Ducted systems
- New construction

This guide is organized into four one-page application types to assist in sizing and selecting ASHPs for cold climates.
Application: Design and specification

1. Determine end-user requirements
2. Assess building components
   a. Building envelope: Heating and cooling loads
   b. Electrical service
   c. Ductwork
3. Evaluate distribution and zoning options
4. Select system model and capacity
5. Identify physical component locations
6. Confirm specification data
Determine end-user requirements

- Full vs. partial load
- Comfort parameters
- Noise & aesthetic considerations
- Budget and financing
 Assess Building Components: Heating and cooling loads

- Too small: Doesn’t do the job
- Too big: Inefficient, cycles frequently
- But how to get it “just right?”

- ACCA “Manual J” sizing calculations
  - Better inputs → more accurate results
  - Air leakage, shading important
  - Builds in adequate safety margins
Assess Building Components: Electrical Service

- Size and condition of electrical service
- Calculations for added loads (NEC 220.83)
Assess Building Components: Ductwork

Fossil fuel furnaces: 120-180 cfm/ton
Heat pumps: 300+ cfm/ton

- Space constraints
- Sizing
  - Supply trunk
  - Branches
  - Return ducts
- Location
- Leakage
- Insulation
Distribution & zoning options

- Avoid putting heads in small rooms
- Consider multiple options
  - Ductless
  - Compact ducted
  - Fully ducted
Small room solutions

- Compact-ducted heads
- Electric baseboard/radiant for very small rooms
Select system model and capacity

- **Extended performance data**
  - NYS: 90-120% Manual J design load
  - Performance under local conditions
  - Modulation range
  - Backup heating?
  - Airflow requirements

- **Single vs. multiple outdoor units**
  - Aesthetic impacts
  - Lineset lengths
  - Efficiency, modulation
  - Redundancy

- **Controls**
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cooling</strong></td>
<td>BTU/H</td>
<td>21,000</td>
<td>BTU/H</td>
<td>17,200</td>
<td>6,450</td>
<td>2,220</td>
<td>4.8</td>
<td>0.69</td>
</tr>
<tr>
<td><strong>Heating at 47°F</strong></td>
<td>BTU/H</td>
<td>30,000</td>
<td>BTU/H</td>
<td>20,300</td>
<td>5,160</td>
<td>3,390</td>
<td>1,720</td>
<td>93 / 93</td>
</tr>
<tr>
<td><strong>Heating at 17°F</strong></td>
<td>BTU/H</td>
<td>20,300</td>
<td>BTU/H</td>
<td>13,700</td>
<td>2,800</td>
<td>2,800</td>
<td>1,320</td>
<td>17,250</td>
</tr>
<tr>
<td><strong>Heating at 5°F</strong></td>
<td>BTU/H</td>
<td>20,300</td>
<td>BTU/H</td>
<td>2,960</td>
<td>2,960</td>
<td>2,960</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Heating at -4°F</strong></td>
<td>BTU/H</td>
<td>17,250</td>
<td>BTU/H</td>
<td></td>
<td></td>
<td>14,210</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Heating at -13°F</strong></td>
<td>BTU/H</td>
<td>14,210</td>
<td>BTU/H</td>
<td></td>
<td></td>
<td>21,000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Identify physical component locations

- **Outdoor units**
  - Visual and sound impact
  - Proximity to indoor units
  - Drip lines, walkways
  - Mounting options

- **Indoor units**
  - Visual impact
  - Clearances and existing furniture/windows/doors
  - Coverage and throw
  - Condensate

- **Branch boxes**
Confirm specification data

- Equipment compatibility
- Minimum & maximum lineset lengths
- Derates
- Use tables or software tool
Applications highlights

- Do listen carefully to end-users
- DO size equipment thoughtfully
- ✗ DON’T assume existing ductwork and electrical service are adequate
- ✗ DON’T install ductless heads in small rooms
  - DO consider multiple options
  - DO confirm specification data on completed designs
Installation

1. Confirm locations
2. Install indoor unit(s)
3. Install outdoor unit
4. Interconnect system
5. Leak test and evacuate
6. Charge and test system
7. Educate end users
Confirm locations

- **Indoor units**
  - Windows, doors, and furniture
  - Clearances
    - Top clearance

- **Outdoor units**
  - Visual impact
  - Windows, walkways, etc.
  - Clearances for service and airflow
Install indoor unit(s)

1. Locate studs
2. Secure mounting bracket
3. Drill hole
   a. Size
   b. Location
   c. Pitch
4. Install wall sleeve
5. Attach control wiring
6. Hang unit
7. Seal wall penetration
Seal wall penetrations
Install outdoor unit(s)

- Level, on solid ground
- Above average maximum snow depth for airflow
- Drainage for defrost
- Avoid drip lines
  - Consider awnings
DON’T: Mount outdoor units on wood-frame walls
Interconnect system

- Linesets
  - Tubing--Flaring
  - Covers
  - Insulation

- Wiring
  - Line voltage
  - Control

- Condensate
Linesets: Making a good flare

- Cutting
- Deburring
- Forging the flare
- Assembling
- Tightening
- Testing
Cutting

- Good quality tubing cutter
  - Sharp cutting wheel
- Square cut

*Take your time!*

Deburring

- Don’t gouge or scratch
- Don’t thin tubing wall
Flaring tools

Clutch

Depth gauge
Visual inspection

- Flare
  - Symmetrical
  - Correct dimensions
  - Shiny
  - Free of defects
- Alignment
Assembly lubricant/sealant

- POE oil or NYLOG
- Assists assembly, allows hand-tightening
- Allows flare nut to spin against back of flare
- May improve seal
- May affect torque specs
**DO:** Use torque wrenches

Flare connections:

- Too loose → Leak
- Too tight → Crushed flare → Leak
- Torque wrench → Just right
Other tips

- Always redo leaking flares
- Don’t use other leak sealants
- Cut off factory flares on linesets
- Use OEM flare nuts
- Lineset size determined by indoor head
Interconnect system: Line set insulation
Interconnect system: Electrical

- **Line voltage (240V AC w/ ground)**
  - Properly size wire and breaker
  - Disconnect
  - Exterior conduit
  - Surge protection

- **Control wires (240V AC + 12-24 V DC signal w/ ground)**
  - Use manufacturer’s recommended wire gauge
  - Outdoor rated
  - Avoid splices

Always follow NEC!
Interconnect system: Condensate

- **Gravity**
  - Pitch: ¼” per foot
  - Avoid traps
  - Secure piping
- **Condensate pump**
  - Wire PMI
Leak test and evacuate

Refrigerant leaks:

- Bad for efficiency, durability, climate
- Majority of leaks can be prevented with thorough testing

Four steps for leak testing:

1. 500 PSI standing pressure test
2. Bubble solution
3. Vacuum decay test
4. Electronic leak detector
Charge and test system

- Calculate trim charge
- Weigh in & record trim charge
- Configure controls
- Test run
  - Operation
  - Delta T
  - Airflow/Static pressure
  - Delivered capacity

Example: LMU300HHV

Each branch pipe
A = 82 ft.
B = 16 ft.
C = 49 ft.

Additional Charge
= (82 - 24.6) x 0.22
  + (16 - 24.6) x 0.22
  + (49 - 24.6) x 0.22
  - (4 - 3) x 5.29
= 10.82 oz.

LG
End-user education

*Education starts during sales & design process and continues through installation and service*

- Create realistic expectations
- Explain basic operation
- Best practices for efficiency
- Manuals and warranties
- Maintenance and service
Mitsubishi MSZ-FH heat pump quick guide & FAQ

Basic operation:
1. Press OFF/ON to start operation.
2. Press MODE to select operating mode:
   - AUTO
   - COOL
   - DRY
   - HEAT
   - FAN
   * Do multizone systems, all heads must be in the same mode for correct operation. AUTO mode should not be used.
3. Press TEMP + or – to increase or decrease room temperature

Airflow speed and direction:
1. Press FAN button to select fan speed. AUTO is recommended for general operation. Lower fan speeds increase dehumidification but may increase risk of condensation.
   - AUTO
   - Quiet
   - Low
   - Medium
   - High
   - Super High
2. Adjust airflow horizontal pattern with WIDE VANE.
3. Adjust left and right vertical pattern with L-VANE-R.
   Auto ( ) optimizes direction for heating or cooling.

Smart set:
1. Use the SMART SET button to allow heating temperatures to be set as low as 50°F.

Why don’t you recommend setting back the temperature or programming a schedule? Heat pumps operate most efficiently with a “set it and forget it” approach. If you are leaving your house for several days, you can set the temperature back several degrees—just remember, it may take several hours to reach your target temperature when you return.

Why is the temperature on my remote doesn’t match my room thermostat. Why is that? Your Mitsubishi heat pump senses temperature at the indoor unit itself, not at the remote. The temperature there will often be a few degrees different than the temperature where the thermostat is located. Find a setpoint at which you’re comfortable, even if it’s a few degrees different that what you’ve used in the past.

What do I need to do to register my warranty? Nothing! Snug Planet will register your heat pump with Mitsubishi.

What maintenance do I need to do? To clean the filters, turn off the indoor unit. Pop open the front cover by pulling the tabs on either side of the unit. Remove the two filters and gently clean them using a vacuum attachment brush. Put the filters back in place, snap the front cover closed, and turn the unit back on. Depending on unit location, pets, and other dust sources, we recommend cleaning filters every 2-6 weeks, or when visibly dirty.

When should I call for professional service? Once a year, heat pumps need a thorough cleaning and check-up to maintain efficiency, longevity, and warranty coverage. Snug Planet will reach out to schedule your first annual service visit, which is included in your purchase price. At that time, your Snug Planet technician will discuss our service plans. And if anything doesn’t seem right, or you have any questions about your system, please give us a call!

607-277-SNUG (7684)
1730 Mecklenburg Rd., Ithaca, NY 14850
www.snugplanet.com
Applications highlights

✗ DON’T mount indoor unit too close to the ceiling
  DO seal wall penetrations

✗ DON’T use wall brackets on wood-frame walls
  DO elevate outdoor unit
  DO follow manufacturer’s instructions for wiring

✗ DON’T skimp on leak testing
  DO get the trim charge right
  DO educate end-users
Operation and maintenance

- **Annual preventive maintenance**
  - Visual inspection
  - Clean filters, coils, blower wheel as needed
  - Clean and check condensate pan & piping
  - Operational test
  - Noninvasive (“gaugeless”) performance testing
  - End-user check in

- **Diagnosis**
  - Airflow
  - Charge
  - Electrical
  - Controls
  - “Operator error”
Troubleshooting: Noninvasive testing
Troubleshooting: Diagnostic tools

![Image of diagnostic tools]

<table>
<thead>
<tr>
<th>Component</th>
<th>Target</th>
<th>Present</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inv Td</td>
<td>158.0 °F</td>
<td>142.6 °F</td>
</tr>
<tr>
<td>Suction</td>
<td>50.0 °F</td>
<td></td>
</tr>
<tr>
<td>Discharge</td>
<td>142.6 °F</td>
<td></td>
</tr>
<tr>
<td>Cond Mid</td>
<td>53.1 °F</td>
<td></td>
</tr>
<tr>
<td>Cond Out</td>
<td>99.8 °F</td>
<td></td>
</tr>
<tr>
<td>Heatsink</td>
<td>84.2 °F</td>
<td></td>
</tr>
<tr>
<td>ODU Air Temp</td>
<td>61.7 °F</td>
<td></td>
</tr>
</tbody>
</table>
O & M highlights

DO schedule regular maintenance

DO thoroughly clean heat exchangers, blowers, & condensate drains

✘ DON’T hook up gauges

Do use noninvasive diagnostics tools
Additional resources

- Northeast Energy Efficiency Partnership: [www.neep.org](http://www.neep.org)
- Green Building Advisor: [www.greenbuildingadvisor.com](http://www.greenbuildingadvisor.com)
- Field Performance of Inverter-Driven Heat Pumps in Cold Climates
  

- Manufacturer literature and trainings (LG, Mitsubishi, Fujitsu etc.)
- Jon Harrod articles from *Building Performance Journal*
  - Cold-Climate Heat Pumps Dos and Don’ts
  - Performance Testing Ductless Systems

Jon Harrod, Snug Planet [jharrod@snugplanet.com](mailto:jharrod@snugplanet.com) (email me for reprints)
Installing Air Source Heat Pumps without Call-backs
A one-day hands-on workshop in Ithaca NY on
11/07/2020 9 am – 4:30 pm

Get hands-on experience installing an air source heat pump with the experts. *Start to finish* - experience best practices up close and personal.

**Key Learning Objectives**
- Identify the basic ASHP installation procedure
- Detect potential issues in the installation process and know how to address them
- Understand basic protocols for avoiding common ASHP installation errors
- Recognize best practices for managing refrigerant materials during installation
Questions?