

Cold-Climate Air Source Heat Pumps

Dehumidification in Heating Climates



NYSERDA
New York State Energy Research
and Development Authority

Humidity Control Starts with the Whole Home

Managing indoor humidity is essential for comfort, durability, and efficiency. Cold-climate air source heat pumps (ccASHPs) can remove moisture more efficiently than standard air conditioning systems due to longer runtimes at lower speeds, but dehumidification is a byproduct of cooling, not the main job of the equipment.

Most excess humidity comes from everyday activities, inadequate mechanical ventilation, foundation moisture, or outdoor air leaks. Without proper air sealing, insulation, and ventilation, moisture can build up quickly.

Humidity should be managed in layers—starting with the building shell, followed by ventilation, space cooling equipment, and finally supplemental dehumidification, if needed.

Three-Prong Defense Against Moisture

① First Line of Defense: The Building Shell

Before addressing the HVAC equipment or dehumidifiers, it's important to evaluate the building envelope. The components of the envelope or shell — such as walls, attic, foundation, windows, and doors — are crucial in regulating how much moisture enters the home.

Air leaks in the building envelope allow warm, humid outdoor air to infiltrate the home. This raises the home's latent load, adding strain on ventilation and cooling systems and reducing their ability to manage moisture effectively.

What to do:

- ✓ Inspect basements and foundations for bulk water entry. Permeable foundations are a major source of indoor moisture and should be addressed as part of the envelope strategy.
- ✓ Seal gaps and cracks in the attic, around windows and doors, as well as wall and floor assemblies.
- ✓ Upgrade insulation to reduce the risk of interior condensation and support overall climate control.
- ✓ Inspect attic ventilation (if vented) – Check for sufficient airflow to prevent moisture accumulation and migration into the living space.

When the shell is sealed tight, mechanical systems—including ventilation and heat pumps—don't have to work as hard to maintain indoor comfort.

Controlling moisture at the envelope reduces energy use, improves comfort, and enhances the performance of any active dehumidification strategy.

Too Much Humidity Indoors Can Lead To:



Mold



Musty Smells



Condensation



Structural Damage



Damp Furnishings



Increased Pests



Poor Air Quality



② Second Line of Defense: Ventilation

After sealing the building envelope, mechanical ventilation is the next crucial layer in humidity control. First, is spot ventilation – in kitchens and bathrooms – to remove moisture from the major indoor sources as they occur. Then, provide a controlled amount of continuous (or scheduled intermittent) whole-house mechanical ventilation. Mechanical ventilation creates airflow through the house, even with a tight envelope, and brings in fresh air. Balanced ventilation with recovery is preferred for optimal airflow and humidity control which in turn supports healthy indoor air quality.

What to do:

- ✓ Confirm spot ventilation is in place and used consistently – Bath fans should run during and after showers; range hoods should run during cooking, especially when boiling.
- ✓ Install or evaluate whole-building ventilation systems – Recommend balanced systems with recovery (ERVs/HRVs) where appropriate. Central-fan, balanced without recovery, and exhaust-only setups may also be effective when properly configured.
- ✓ Verify fan controls and timers – Ensure scheduled ventilation systems are set to provide adequate daily airflow.

When ventilation works properly, it reduces the strain on cooling equipment and helps maintain comfort, air quality, and moisture control year-round.

③ Third Line of Defense: Equipment

Space conditioning equipment, like heat pumps and air conditioners, can support humidity control, but only when appropriately sized and operating correctly. In cold climates, improper sizing often limits how well a heat pump system removes moisture.

How Heat Pumps Remove Humidity

In cooling mode, heat pumps can reduce both temperature and humidity. As warm, humid air flows over the cold coils, moisture condenses and is removed from the air.

Humidity control depends on the runtime of the unit: longer operating cycles leads to more moisture removal, while shorter cycles can reduce performance and comfort.

Why Sizing for Heating Can Create Issues

In regions like New York State, heating loads typically exceed cooling loads. As a result, heat pumps are often sized primarily for winter heating. However, this can lead to oversizing for cooling during the summer months, which results in shorter runtimes and less dehumidification.

Why Modulation Matters

Cold-climate heat pumps (ccASHPs) with modulating compressors can operate at lower speeds for extended periods. This helps maintain comfort and effectively remove moisture during partial load conditions.

The goal is to choose a unit that:

- ✓ Has enough capacity to meet the heating load
- ✓ Stays within its modulating zone during the cooling season

This balance improves efficiency and indoor humidity control.



Common Issues with Oversized Systems:



Short-cycling in cooling mode



Poor humidity control



Reduced comfort and air quality



Higher energy use



Equipment wear and tear

Use Manual S for System Selection

ACCA Manual S provides guidelines for selecting equipment based on the home's Manual J design loads. It includes a set of *Size Factors* and corresponding *Size Limits* to guide equipment selection.

These factors compare the design load to the compressor's capacity, helping ensure a proper match between the building's heating and cooling requirements while considering runtime, modulation, and efficiency.

Table 1: Sizing limitation for heating and cooling loads as derived from ACCA Manual S table N2.3.4

	Size Factor	How to Calculate	Size Limit Must Be		Reason
Heating	Heating Size Factor	Max heating capacity ÷ heating load	Greater than	1.00	The heat pump will have enough capacity to meet the design heating load.
	Min. Compressor Heating	Min. compressor heating capacity ÷ heating load	Less than	0.80	The heat pump will be able to modulate during partial load heating conditions, reducing short cycling.
Cooling	Min Compressor Cooling	Min. compressor cooling capacity ÷ total cooling load	Less than	0.80	The heat pump will be able to modulate during partial load cooling conditions, reducing short cycling.
	Min. Compressor Latent Cooling	Min. compressor cooling capacity ÷ latent cooling load	Greater than	1.00	The heat pump will have enough capacity to remove the latent load.

Heating Load

The first sizing priority is heating. The selected unit should:

- ✓ Meet the home's heating design load
- ✓ Operate within its modulating zone for most of the heating season

Cooling Load and Dehumidification

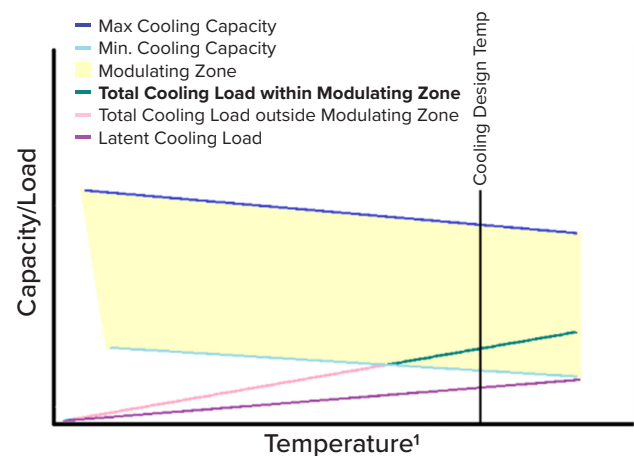
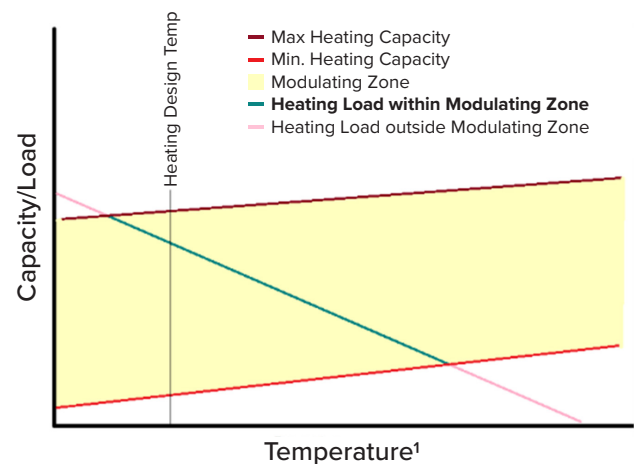
The second sizing priority is cooling performance, specifically humidity control at part load. The system should:

- ✓ Stay in its modulating zone during cooling
- ✓ Remove the full latent (moisture) load, even at low speeds.

What to do:

- ✓ Select a unit with a low minimum cooling capacity and good turn-down performance.
- ✓ Avoid systems that reach their set point too quickly, causing them to shut off before adequate moisture is removed.

The four Size Factor ratios from Manual S help determine whether the heat pump is well-matched to the space's heating, cooling, and dehumidification needs.



¹ <https://ashp.neep.org/#1>

Supplemental Dehumidification: When the System Needs Backup

Even with a tight building shell, balanced ventilation, and a properly sized heat pump, indoor humidity may exceed target levels - especially when outdoor conditions have high humidity with mild temperatures or in homes with high internal moisture loads.

In these cases, active dehumidification may be necessary to maintain comfort, protect the home's finishes, and prevent mold growth.

Common Scenarios That May Require Supplemental Dehumidification:

- The home has high internal moisture sources (e.g., cooking, bathing, laundry, high occupancy)
- The heat pump is oversized or rarely runs in cooling mode (e.g., during spring/fall)
- There are localized humidity issues in areas like basements, bonus rooms, or smaller interior spaces
- Homes that are tightly constructed, where moisture can become trapped indoors
- Occupants report musty odors, condensation, or discomfort even when the system is operating

Options for Active Dehumidification

There are four main strategies to remove moisture beyond what the heat pump can handle in its normal operating modes:

1. Heat Pump Specialty Modes

Some heat pumps feature settings with names such as dry mode, dehumidification mode, or cool-to-dry mode. These settings can extend runtimes to increase moisture removal.

2. Dedicated Dehumidifier

This standalone unit removes latent heat from indoor air. It is typically ducted to draw air in and discharge dry air back out, with condensate piped to a drain.

3. Portable Dehumidifier

These freestanding units remove moisture without ducting. Most collect water in a built-in reservoir that must be manually emptied or can be drained continuously via a hose.



4. Ventilating Dehumidifier

This type combines dehumidification with outdoor air ventilation. It is particularly useful in tightly constructed homes where airflow and moisture control are needed.

What to do:

- ✓ Make use of the heat pump's specialty dehumidification mode if available
- ✓ Recommend dedicated or portable units when indoor humidity regularly exceeds 50%
- ✓ Educate the homeowner that supplemental dehumidification supports—not replaces—heat pump performance
- ✓ Consider ventilating dehumidifiers in tight homes with poor airflow

✓ Seal it. ✓ Ventilate it. ✓ Size it right.

Three lines of defense, one system for lasting comfort.