



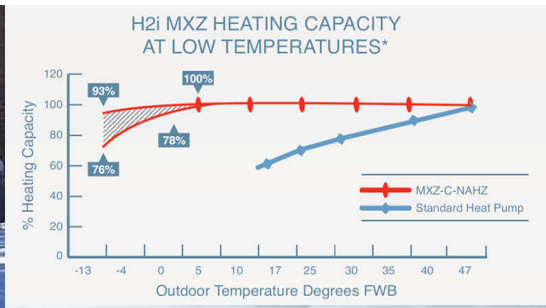
## Cold Climate Air Source Heat Pump Strategies

12-01-2020

Shawn LeMons

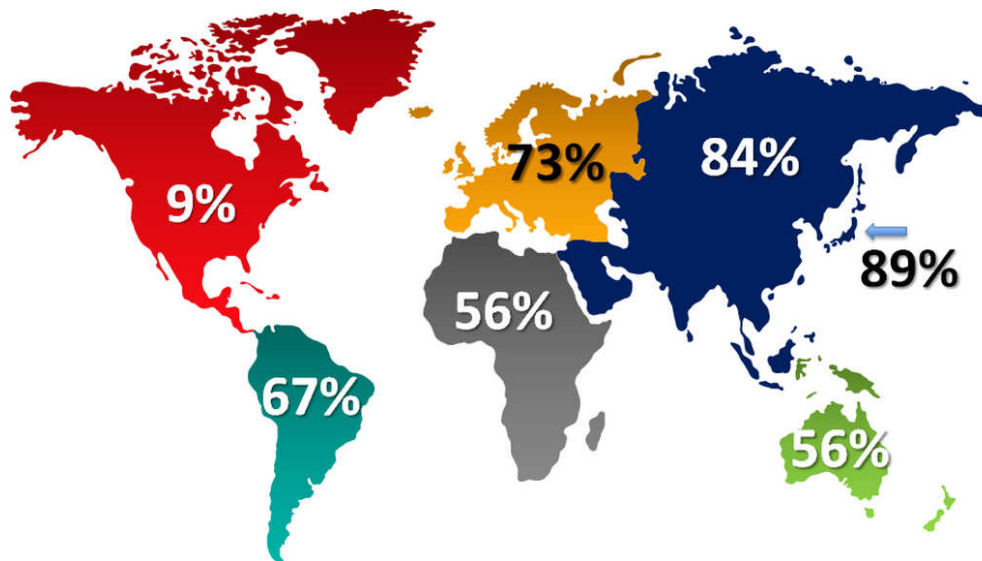
Performance Construction Mgr.

(Former IECC, RESNET, LEED, PHIUS)



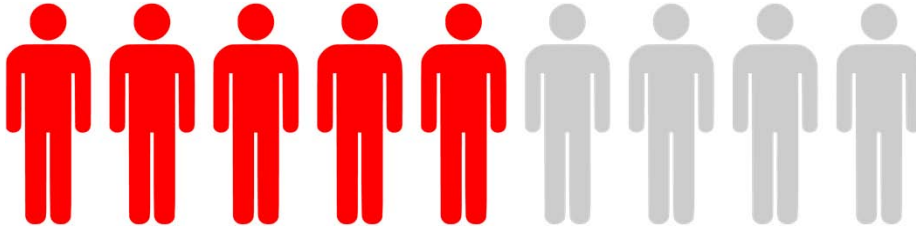
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## ASHP International Market



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## Did you know?

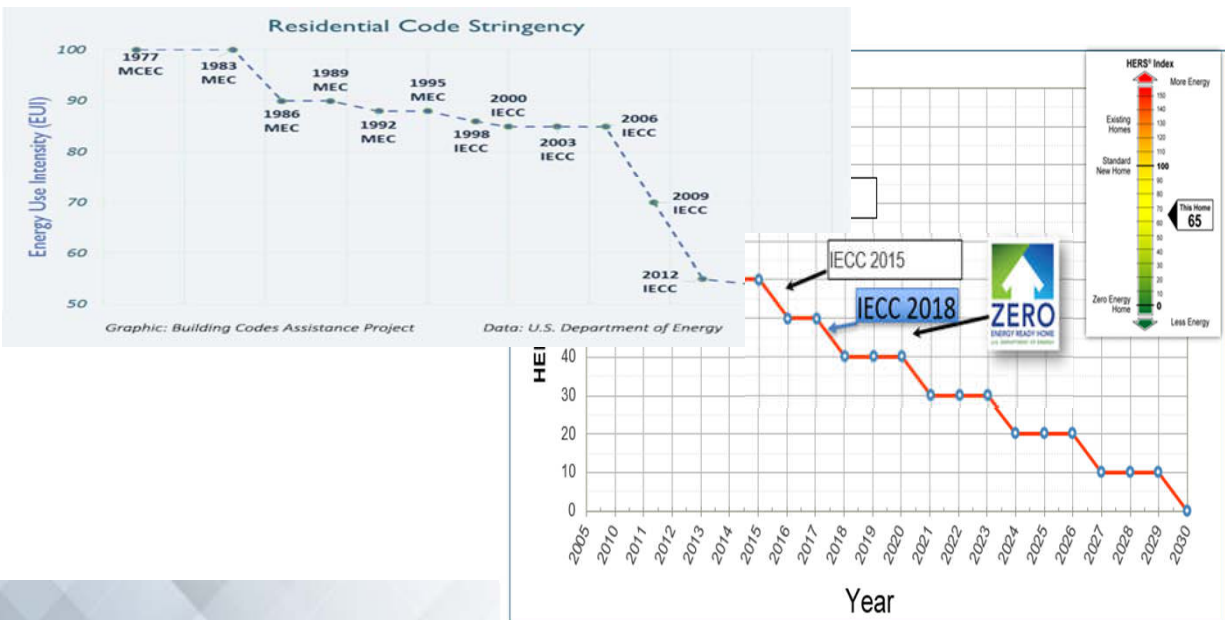


Well over 50% of U.S. HVAC contractors do not size heating & cooling correctly.

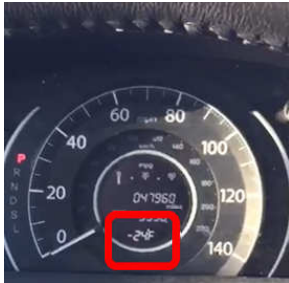
source: U.S. Department of Energy - 2016

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## Performance Changing Over Time

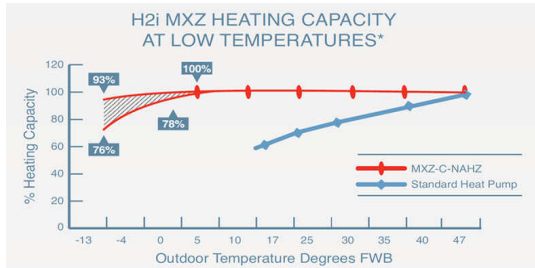


# What is a “Cold Climate” ASHP?



Chicago, January 29, 2019, with 3 days below -20F

<https://drive.google.com/file/d/1QBgBd4JcVBpNpafsl4leWH24GcurEa9b/view>



100% capacity at 5 F  
 76%-93% capacity at -13 F\*  
 Operation down to -18 F and lower\*  
 \* Varies by outdoor model



VCHP systems - North Pole, AK



Above spec performance is common

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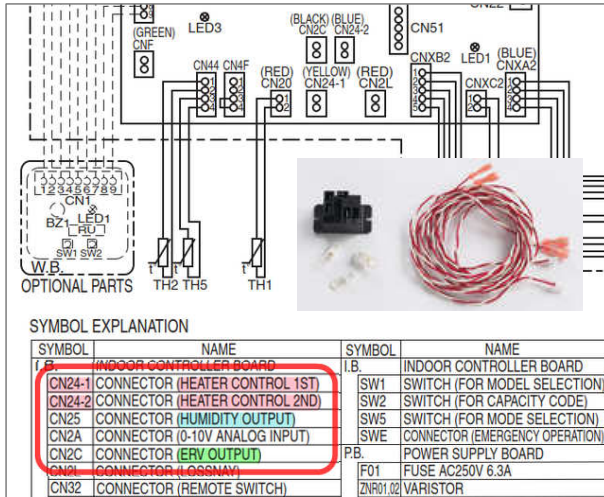
## Heat Pumps Have Evolved

Air Handler	Ceiling Mount	Floor Mount	Horizontal Ducted	Controls
SVZ 12-36 PVA 12-42	SLZ 9-18 EZ FIT™ MLZ 9-18 PLA 12-42 PCA 24-42	KJ 9-18	SEZ 9-18 PEAD 9-42	kumo cloud® kumo touch™ Wireless Sensor kumo station®
Wall Mount				BACnet/Modbus Interface Thermostat Interface Wired and Wireless Controllers
WR 9-24 HM 9-24 JP 115V 9-12 GL 6-24 D 30-36 EF 9-18 FH 6-18 PKA 12-36	Single-Zone Cooling Only Standard HP Hyper-Heating 		Multi-Zone Standard HP Hyper-Heating 	
Branch Box				
3 and 5 Zone				

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# Integrate Other Equipment

3<sup>rd</sup> Party Thermostats, ERV/HRV and Humidity Fan Integration



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# Backup Heat

Onboard logic to manage electric heat when needed.

Mode Change	Condition									
	(To -T <sub>RA</sub> ) > 2.7 ° F [1.5 °C]	AND	T <sub>RA</sub> has not increased by 0.9 °F [0.5° C] in X min	EH1 ON for > 7 min	AND	(To -T <sub>RA</sub> ) > 2.7 ° F [1.5 ° C]	AND	T <sub>RA</sub> has not increased by 0.9 ° F [0.5° C] in 7 min	(To -T <sub>RA</sub> ) < 0.9 ° F [0.5° C]	
EH1 ON	○	AND	○							
EH2 ON				○	AND	○	AND	○		
EH1 OFF									○	
EH2 OFF									○	

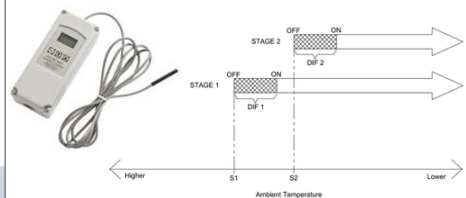
KEY

- EH1: Electric Heater 1
- EH2: Electric Heater 2
- To: Set point temperature
- T<sub>RA</sub>: Return Air temperature
- X: Time delay (Selectable. Default is 24 min. Selectable to 14, 19, or 29 min)

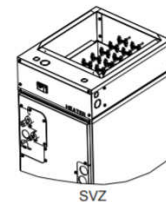
Can used with any heat source control

Can used with any heat source control

Elec Heat Lockout



Heat Kit



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## CEE Case Study 2 (MN, June '18)

Table 1. A comparison of the weather normalized annual performance for several heating systems in this Minneapolis home.

	Heating Load	Annual COP	Electric Use	LPG use	Natural Gas Use	Total Energy Use	Annual Operating Costs <sup>1</sup>	Emissions <sup>2</sup> CO <sub>2</sub>
	mmBtu	-	kWh	therms	therms	mmBtu	\$	equiv lbs
ccASHP w/ ER boost	63.1	1.84	10,075	0	0	34.3	\$1,310	11,499 <sup>3</sup>
Electric Resistance	63.1	0.99	18,491	0	0	63.0	\$2,404	21,104
LPG Furnace	63.1	0.79	503	747	0	76.4	\$1,404	11,650
Natural Gas Furnace	63.1	0.79	503	0	747	76.4	\$807	9,699

1. Average residential pricing in 2017 for propane, natural gas, and electricity from Energy Information Administration were \$0.13/kWh for electricity, \$1.57/gallon for LPG, and \$0.95/therm for natural gas.

2. Monthly average emissions in 2017 monthly were used. For electricity, 1.14 equivalent lb/kWh, 11.7 lb/therm for natural gas, and 13.0 lb/gal for LPG. (See Edwards et al 2018).

3. Using the NSP value of 0.894 lbs/kWh<sup>1</sup> the ccASHP with ER booster annual emissions would be 9,007 equiv. lbs, a 2% reduction over the natural gas furnace.

### Site Characteristics

- 2 bedroom, one bath, 1.5 story single-family home
- 1924 Bungalow, 1600 sqft, with efficiency upgrades
- 50,000 btu/hr heating load calculation at -11°F
- 26,000 btu/hr measured heating load at -11°F
- 18kW electric resistance ducted heat strip

<https://www.mncee.org/MNCEE/media/PDFs/ccashp-Study-2-MPLS.pdf>

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PVA-A36

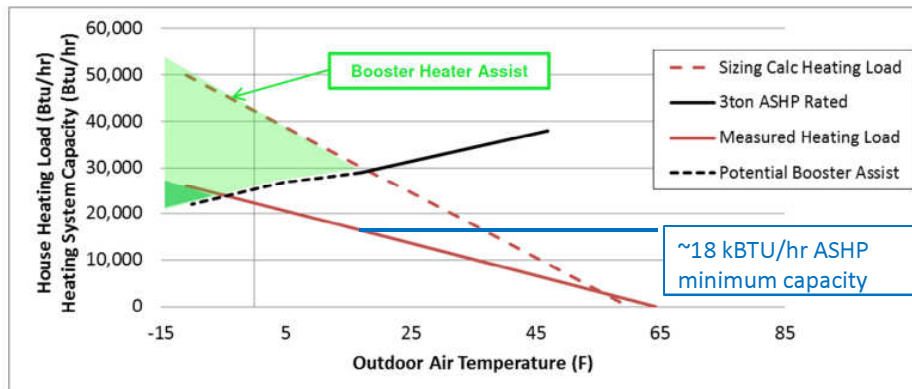


PUZ-HA36NHA5



## CEE Case Study 2 (MN, June '18)

Figure 3. Capacity vs. Outside Air Temperature



### Site Characteristics

- 2 bedroom, one bath, 1.5 story single-family home
- 1924 Bungalow, 1600 sqft, with efficiency upgrades
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<https://www.mncee.org/MNCEE/media/PDFs/ccashp-Study-2-MPLS.pdf>

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PVA-A36



PUZ-HA36NHA5



## CEE Case Study 2 (MN, June '18)

### SPECIFICATIONS: PVA-A36AA7 & PUZ-HA36NHA5

Heating at 47°F <sup>2</sup>	Maximum Capacity	BTU/H	40,000
	Rated Capacity	BTU/H	38,000
	Minimum Capacity	BTU/H	18,000
	Maximum Power Input	W	3,360
	Rated Power Input	W	3,040
Heating at 17°F <sup>3</sup>	Power Factor	%	88.7
	Maximum Capacity	BTU/H	38,000
	Rated Capacity	BTU/H	29,000
	Maximum Power Input	W	5,400
	Rated Power Input	W	3,230
Heating at 5°F <sup>4</sup>	Maximum Capacity	BTU/H	38,000
	Maximum Power Input	W	6,100
SEER			17.8
EER <sup>1</sup>			12.5
			11.0
			3.66
			2.06
			1.82
ENERGY STAR® Certified (ENERGY STAR products are third-party certified by an EPA-recognized Certification Body)			Yes

#### Site Characteristics

- 2 bedroom, one bath, 1.5 story single-family home
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- 26,000 btu/hr measured heating load at -11°F
- 18kW electric resistance ducted heat strip

## CEE Case Study 2 (MN, June '18)

If the Manual J was closer to the 26 kBTU/h heat load...

### DIAMONDSYSTEM BUILDER

System 1

PUZ-HA36NHA5

3/8 / 5/8  
50.0ft (0)

PVA-A36AA7

Pipe Dia. Liquid / Gas	Model Number	Clg Total (Sens.)
Pipe Length (Elbows)	Address/Group / Room / Tag Ref.	Htg Total

31,931 BTU/h (26,216 BTU/h) Est. Cooling Discharge Air Temp: 57.2

29,701 BTU/h Est. Heating Discharge Air Temp: 95.4

**Correction Factors**

Temperature: 1.03 0.82

Piping Length: 0.96 0.99

Defrosting: - 1.00

User Derate: 1.00 1.00

Total Derate: 0.96 0.78

Additional Refrigerant: 0.0 lb

Total Refrigerant Amount: 12.0 lb

**Conditions (°F)**

**Cooling**

Indoor DB 80.0 Humidity 51.8%

Outdoor DB 92.0

**Heating**

Indoor DB 70.0

Outdoor DB -11.0 Humidity 71.6%

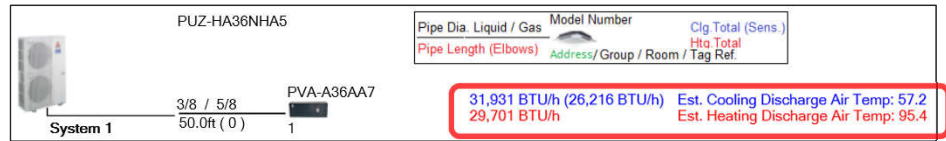
Plus 10 kW heat kit (two 5 kW stages)  
 for 17+17 kBTU/hr modulated boost heat

Verify system combination and capacity at design conditions.

Use this capacity and other spec sheet details for Manual S & Manual D compliance.

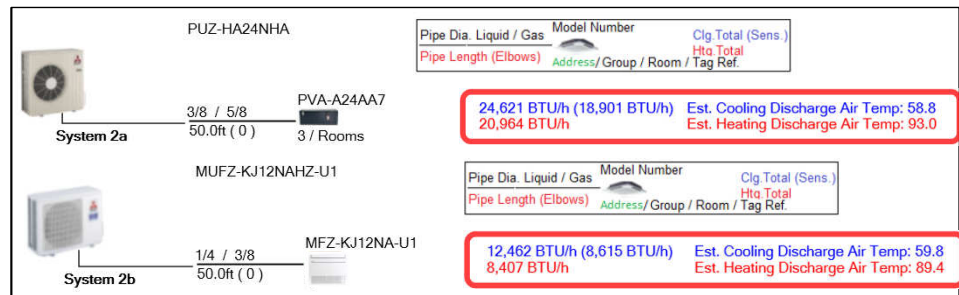
## CEE Case Study 2 – Manual S Decision

1 outdoor  
1 ducted indoor  
18 kBTU/hr min heat  
~1400 watts at ~20°F



or...

2 separate systems:  
Ducted for rooms  
Ductless for Liv & Kit  
2.9 kBTU/hr min heat  
~200 watts at ~60°F



Cooling minimums are similar.

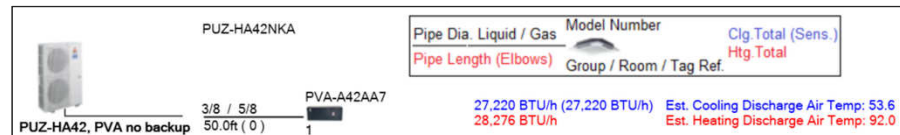
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## High Altitude Example

### Design Conditions

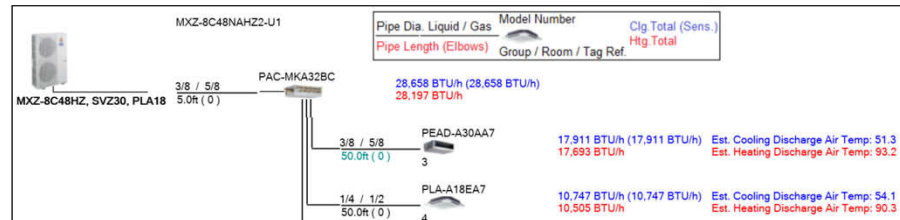
- 26 kBTU/h heating / 13 kBTU/h cooling loads
- -11°F / 95°F design temps @ 10,000 ft elevation

1 outdoor with 1  
ducted indoor



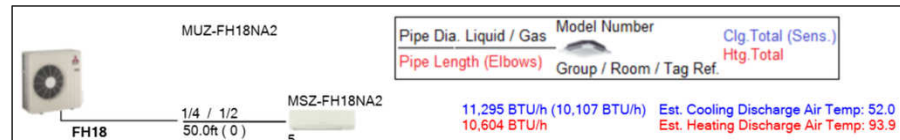
OR...

1 outdoor with  
ducted + ductless  
indoor units



OR...

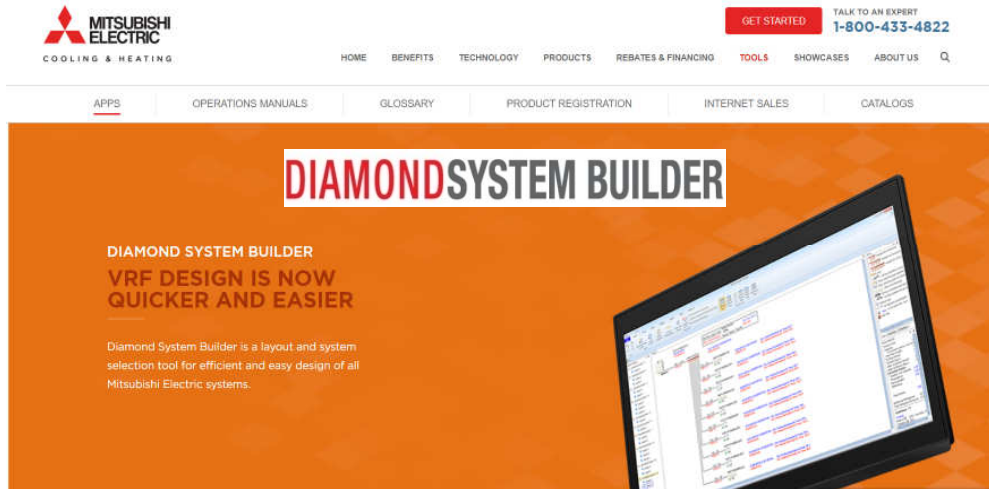
2 separate systems



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## Design Resources

Extensive tools for Architects, Builders, Designers, Installers, and Homeowners



<https://www.mitsubishicomfort.com/diamond-system-builder>

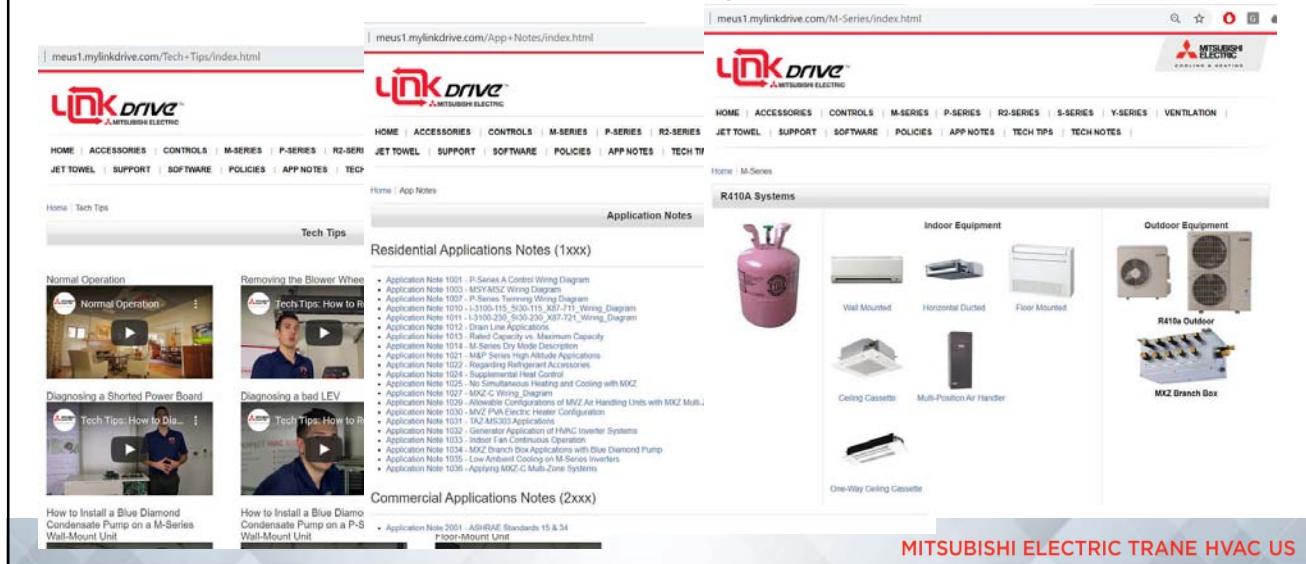
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Use DSB with  
Manual S  
equipment  
selection



## Design Resources

Extensive tools for Architects, Builders, Designers, Installers, and Homeowners





# Cold Climate Installation Guidelines

Need to managing drainage, ice, and snow level



Good, but...



Better

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COOLING & HEATING

## 3 Important Points to Remember When Installing

Follow these recommendations to ensure full capacity and proper defrost in cold areas.

Wind and snow can significantly reduce capacity and the defrost efficiency. Below is a quick install guide for cold weather.

### 1 Installation location

Be aware of the prevailing wind direction in winter and install the outdoor unit where it is sheltered from the wind where possible. When not possible, it is recommended to use an accessory wind buffer.

**Correct installation:** Unit is installed in a sheltered location.

**Wrong installation:** Unit is installed in an exposed location.

### 2 Measures for drainage of water

**Case 1: Unit installed near walkway**  
Do not install the unit near a walkway as the drainage water can freeze causing a slip hazard.

**Correct installation:** Install at a sufficient height from the ground to prevent problems caused by frost drainage water. If there is a drainage pipe, ensure proper drainage from the drainage outlet.

**Wrong installation:** Install too close to the ground.

**Case 2: Multiple units are installed**  
Do not install units on top of one another as it may cause frozen drainage water on the bottom unit.

**Correct installation:** Place units side by side.

**Wrong installation:** Install units on top of one another.

### 3 Measures for snow

**MSP Series**  
**Unit is installed on the ground**  
To avoid the adverse effects of snow, ice and defrosting issues, install the unit on a stand to ensure a sufficient height from the ground.

**Correct installation:** Install a stand to ensure a sufficient height from the ground.

**Wrong installation:** Install the unit directly on the ground.

**Correct installation:** Use a stand to add sufficient height to protect the unit's heat exchanger from snow and prevent ice buildup during defrost operation.

**Wrong installation:** Install the unit directly on the ground.

**Necessity of accessories (rain socket & centralized drain)**

Drain outlet	Single region (North America & Europe)	Cold region (Russia & Korea)	Remarks
Drain outlet	Not used	Not used	Prevents freezing
Centralized drain	Not used	Not used	Prevents freezing
Drain outlet	Not used	Not used	Prevents freezing
Centralized drain	Not used	Not used	Prevents freezing

Use a stand to add sufficient height to protect the unit's heat exchanger from snow and prevent ice buildup during defrost operation.

**Correct installation:** Use a stand to add sufficient height to protect the unit's heat exchanger from snow and prevent ice buildup during defrost operation.

**Wrong installation:** Install the unit directly on the ground.

Cold Climate Installation Guidelines - <https://tinyurl.com/y6blz8uz>

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# NEEP - ASHP Guides



Air Source Heat Pump Buying Guide

## Part 1: Air Source Heat Pumps - The Basics

[https://neep.org/sites/default/files/resources/ASHP\\_buyingguide\\_5.pdf](https://neep.org/sites/default/files/resources/ASHP_buyingguide_5.pdf)

### Features of Air Source Heat Pumps



## Getting The Most Out of Your Heat Pump

<https://neep.org/sites/default/files/GettingTheMostFromYourHeatPumpConsumerGuideFINAL.pdf>

### Settings are the Key to Great Heat Pump Performance

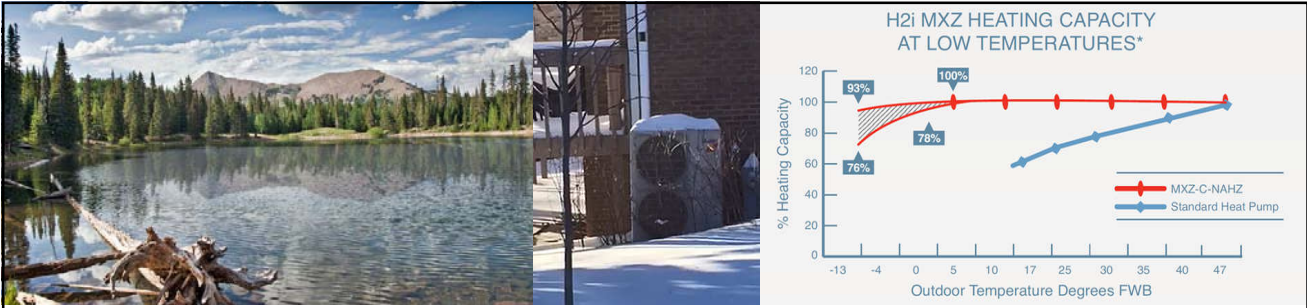
Use these settings, whether your heat pump is ducted or ductless, to maximize savings and improve your comfort:

**Pro Tip!** If your central heat is oil or propane, you can expect your electric bill to increase significantly in cold weather.

#### Set it and Forget it

- Avoid frequently adjusting the thermostat; try to keep indoor settings steady.
- It's fine to adjust temperatures up and down as needed for comfort (e.g. turn it down at night if you like it a bit cooler).
- However, unlike conventional heating systems, deep setbacks of cold-

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## Questions?

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