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Take energy efficiency to a new level

Residential New Construction Passive House Multi-family buildings with five units or more

PASSIVE HOUSE INCENTIVE STRUCTURE FOR MULTI-FAMILY (5 UNITS OR MORE)				
Incentive Timing	Activity	Incentive Amount	Max Incentive (Per Unit)	Max Incentive (Per Project)
Pre-Construction	Feasibility Study[1]	Up to 100% of Feasibility Study Costs	N/A	$5,000.00
	Energy Modeling[2]	75% of Energy Modeling Costs (Before 90% Design Drawings)	$500.00	$30,000.00
		50% of Energy Modeling Costs (90% Design/50% Construction)	$250.00	$15,000.00
Post Construction	Certification[3]	Up to 100% of Certification Costs	$1,500.00	$60,000.00

1. Feasibility Study will require documentation in the form of a Feasibility Study report and invoice from the Passive House Consultant
2. Incentives will only be awarded prior to 50% Construction Drawings for Passive House projects. No incentives will be granted after 50% Construction Drawing set.
3. Certification may be either through PHIUS, PHI, or EnerPHit certification offerings.

Next steps you can take...
Contact your Energy Efficiency Representative or

Go to EnergizeCT.com or call 1-877-WISE USE for more details.

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Heat Pump Design and Installation Best Practices

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Principal Building Systems Consultant
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212.564.5800 x1110

Since 1972, Steven Winter Associates, Inc. has been providing research, consulting, and advisory services to improve the built environment for private and public sector clients.

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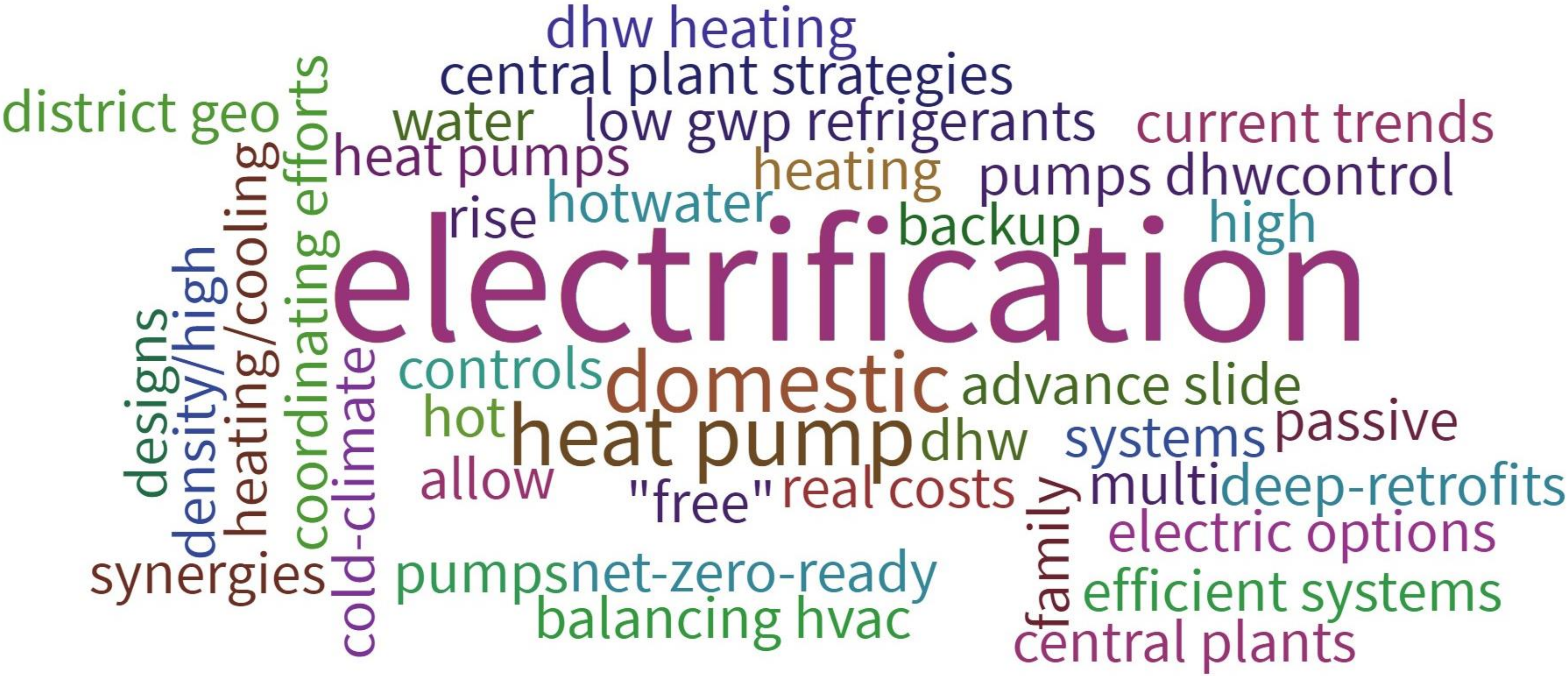

dhw heating
central plant strategies
district geo
water
low gwp refrigerants
current trends
heat pumps
heating
pumps
dhwcontrol
hotwater
rise
backup
high
electrification
designs
density/high
heating/cooling
coordinating efforts
cold-climate
controls
domestic
advance slide
hot
heat pump
dhw
systems
passive
allow
"free"
real costs
family
multi
deep-retrofits
electric options
synergies
pumps
net-zero-ready
balancing hvac
efficient systems
central plants

New Single Family

- Can control the loads with good air sealing and insulation
- Match that load with the right sized system
- Do a great job designing and installing to optimize performance

Existing Single Family

- Paybacks and ROI's for HPs work well in retrofits
- Especially when the replace delivered fuels like oil or propane

Passive House MF

- Heat Pumps in high-performance (Passive House) perform very well when very small capacity equipment is used

Learning Objectives

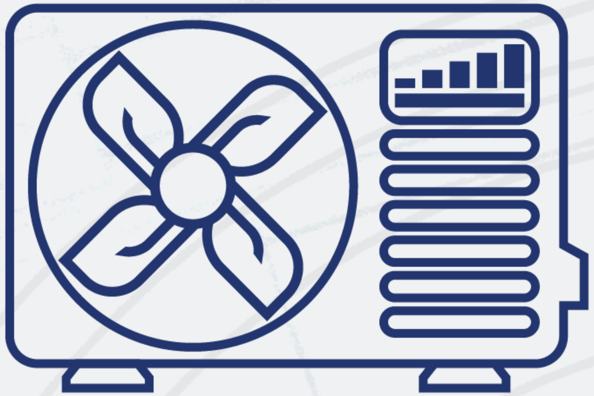
Understand heat pump technology and its applications

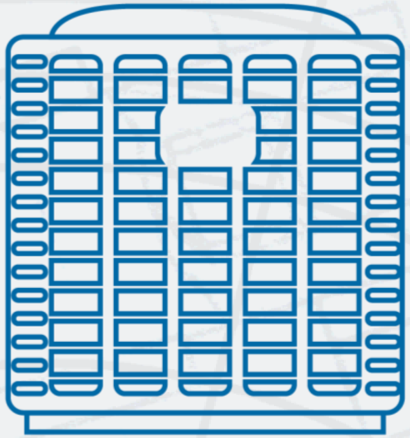
Determine the most appropriate system configuration

Recognize the signs of a quality installation

Properly commission new installations

System Design: Sizing and Selection





Determine the Requirements

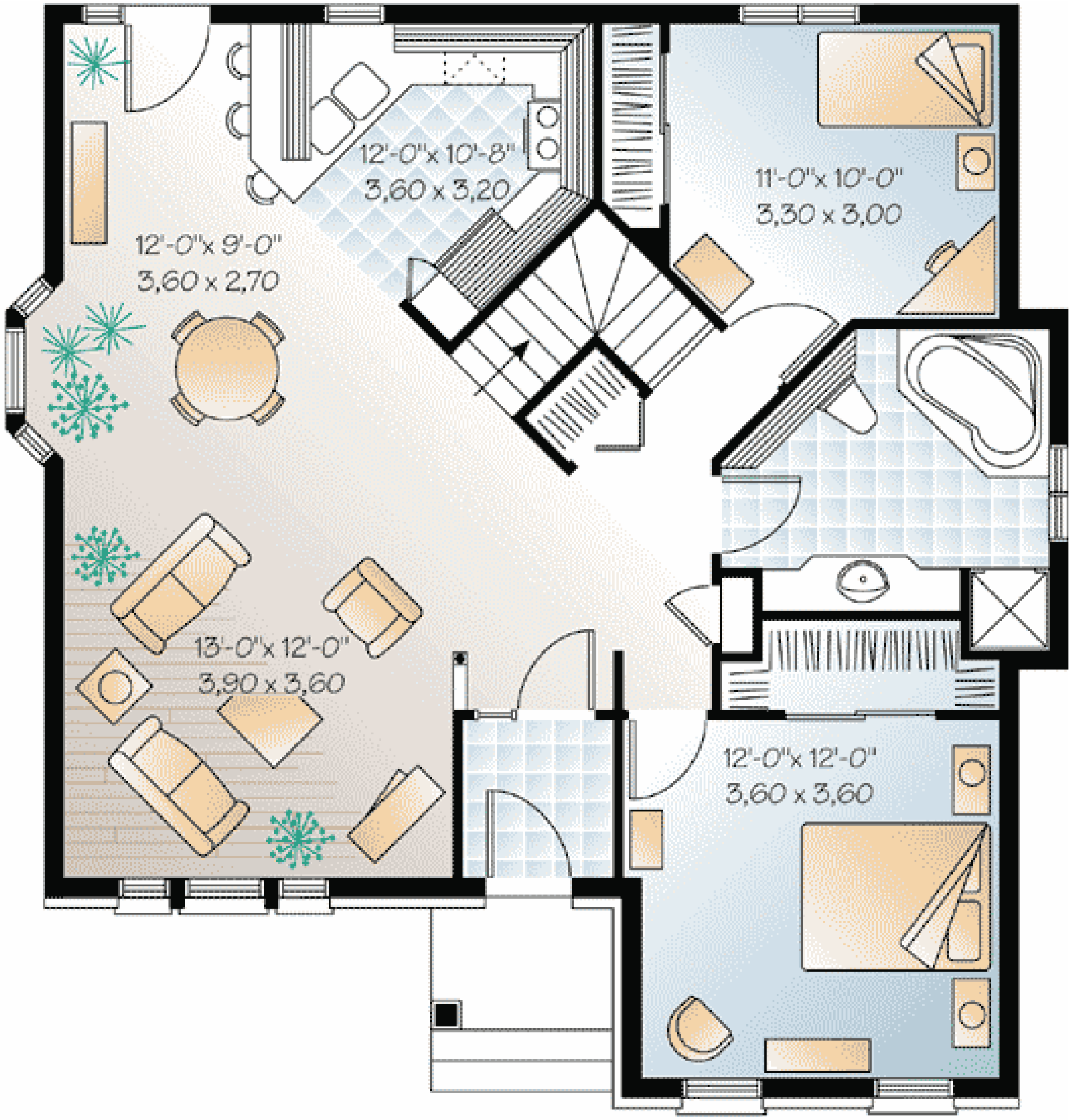
- As a first step, gather the information that is needed to determine what the most appropriate heat pump option is for a particular home.

Customer Goals

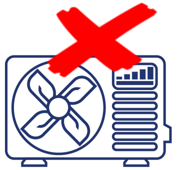
- Comfort
- Cost Savings
- Environment

Home Layout

- Open Floor Plan
- Compartmentalized



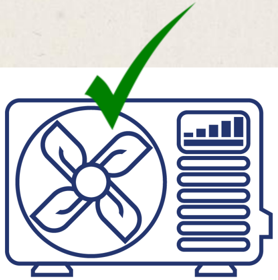
Proper Sizing is Key



Too Small

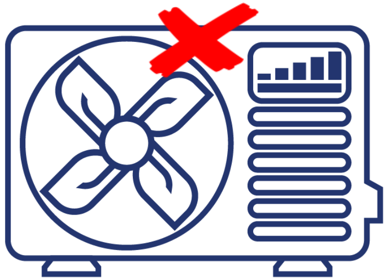
System will not keep the house warm on the coldest days

- Poor comfort, or need for backup heat
- Slow catch up if using thermostat setbacks



Just Right

- Comfort
- Efficiency
- Durability



Too Big

System will cycle on and off

- Poor comfort
- Poor energy efficiency
- Poor durability
- More expensive

Resources

1. Guide to Sizing & Selecting ASHPs in Cold Climates
   http://www.neep.org/sites/default/files/Sizing%20%26%20Selecting%20ASHPs%20In%20Cold%20Climates.pdf

2. Guide to Installing ASHPs in Cold Climates
   http://www.neep.org/sites/default/files/Installing%20Air-Source%20Heat%20Pumps%20in%20Cold%20Climates.pdf

ACCA

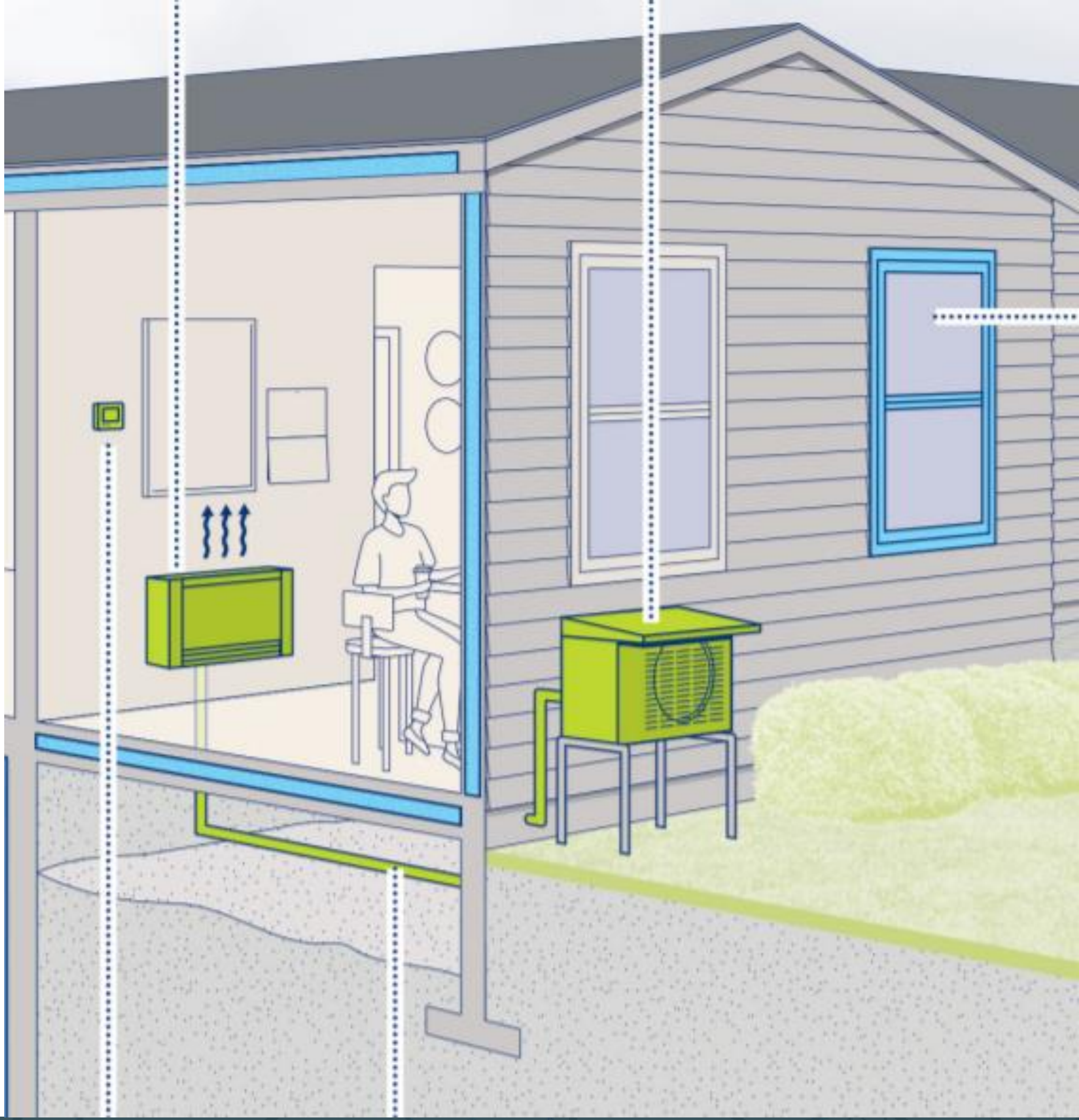
- ACCA Manual J: Residential Load Calculation
- ACCA Manual D: Residential Duct Design
- ACCA Manual T: Air Distribution Basics
- ACCA Manual S: Residential Equipment Selection

System Types Mini-Split

- Smaller decentralized air-source heat pump systems
  - Split and Mini Split <1.5 Tons

- Here are one-to-one systems where you'll have one outdoor unit coupled with one.

- Indoor units are typically small and that indoor unit can be either ductless or ducted.



System Types Multi-Split

- This is again one outdoor unit, but it's connected to multiple indoor units.
- We would have refrigerant piping going from the outdoor unit to a couple of indoor units
  - One outdoor unit
  - 2+ indoor units
  - Ducted, Ductless, or mix
  - 1.5 – 4 tons typ.

Multi-Zone, Multi-Split

- MA Study: More Fan Coils = Less Efficient!
- **Oversizing** one likely reason
- 1 ductless head/bedroom is oversized!
- At least one mfr acknowledges this:

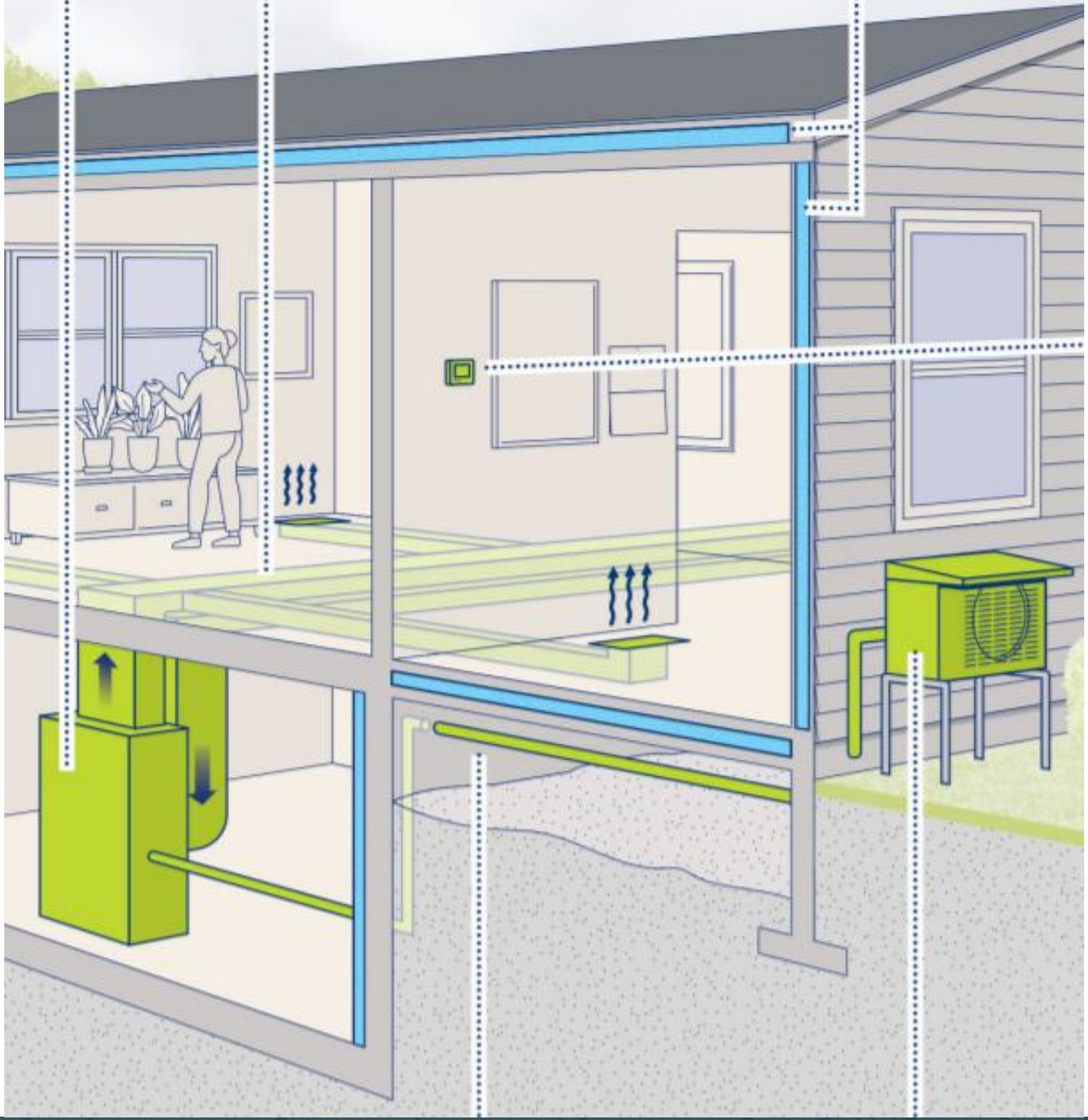
"The outdoor unit should not be selected based on how many indoor units are desired. If the outdoor unit is oversized just to provide a certain number of indoor units for each of the zones, overheating, humidity issues and higher than expected energy usage can occur."

"If an indoor unit nominal capacity is more than 50% higher than the maximum heating or cooling load in a space… humidity, overheating and higher than expected system energy usage can occur. This space should not have its own indoor unit."

http://meus1.mylinkdrive.com/sfiles/M_Application_Note_1036_Applying_MXZ-C_Multi-Zone_Systems-20190530.pdf

System Types Central Split

- One outdoor unit, one central ducted air handler
- More conventional residential A/C system
  - Typ. 2 - 5 tons
  - “Fully ducted”



Example from NEEP Database

American Standard / Mitsubishi Electric M-Series H2i

Singlezone Non-ducted Wall Placement

AHRI Cert #: **202373691**

Outdoor Unit #: **NAXSPB18A112AA**

Indoor Unit #: **NAXWPH18A112AA**

- Maximum Heating Capacity (Btu/hr) @5°F: **20,900**
- Rated Heating Capacity (Btu/hr) @47°F: **20,300**
- Rated Cooling Capacity (Btu/hr) @95°F: **17,200**

SEER	21
EER	12.5
HSPF Region IV	11
Energy Star	✓
Variable Capacity	✓
Maintenance Capacity (Max 5°F/Max 47°F)	68%
Maintenance Capacity (Max 5°F/Max 17°F)	86%
Maintenance Capacity (Max 5°F/Rated 47°F)	102%

Performance Specs

Heating / Cooling	Outdoor Dry Bulb	Indoor Dry Bulb	Unit	Min	Rated	Max
Heating	5°F	70°F	Btu/h	2,696	-	15,400
			kW	0.21	-	2.18
			COP	3.76	-	2.07
Heating	17°F	70°F	Btu/h	2,798	11,500	16,700
			kW	0.2	1.15	2.1
			COP	4.1	2.93	2.33
Heating	47°F	70°F	Btu/h	3,100	18,000	20,000
			kW	0.17	1.28	2.06
			COP	5.34	4.12	2.85
Cooling	82°F	80°F	Btu/h	3,367	-	19,755
			kW	0.15	-	1.4
			COP	6.58	-	4.14
Cooling	95°F	80°F	Btu/h	3,070	18,015	18,015
			kW	0.18	1.44	1.63
			COP	5	3.67	3.24

https://neep.org/ASHP-Specification

Comparing Performance

Two "**one-ton**" ductless heat pumps:

		Outdoor: 47°F		Outdoor: 5°F		Outdoor: -13°F	
	HSPF	Max. Cap	COP	Max. Cap	COP	Max. Cap	COP
HP A	12.5	18,000 Btu/h	**4.15**	8,051 Btu/h	**2.81**	NA	NA
HP B	12.5	21,000 Btu/h	**2.68**	13,600 Btu/h	**2.21**	9,900 Btu/h	**1.81**

https://neep.org/ASHP-Specification

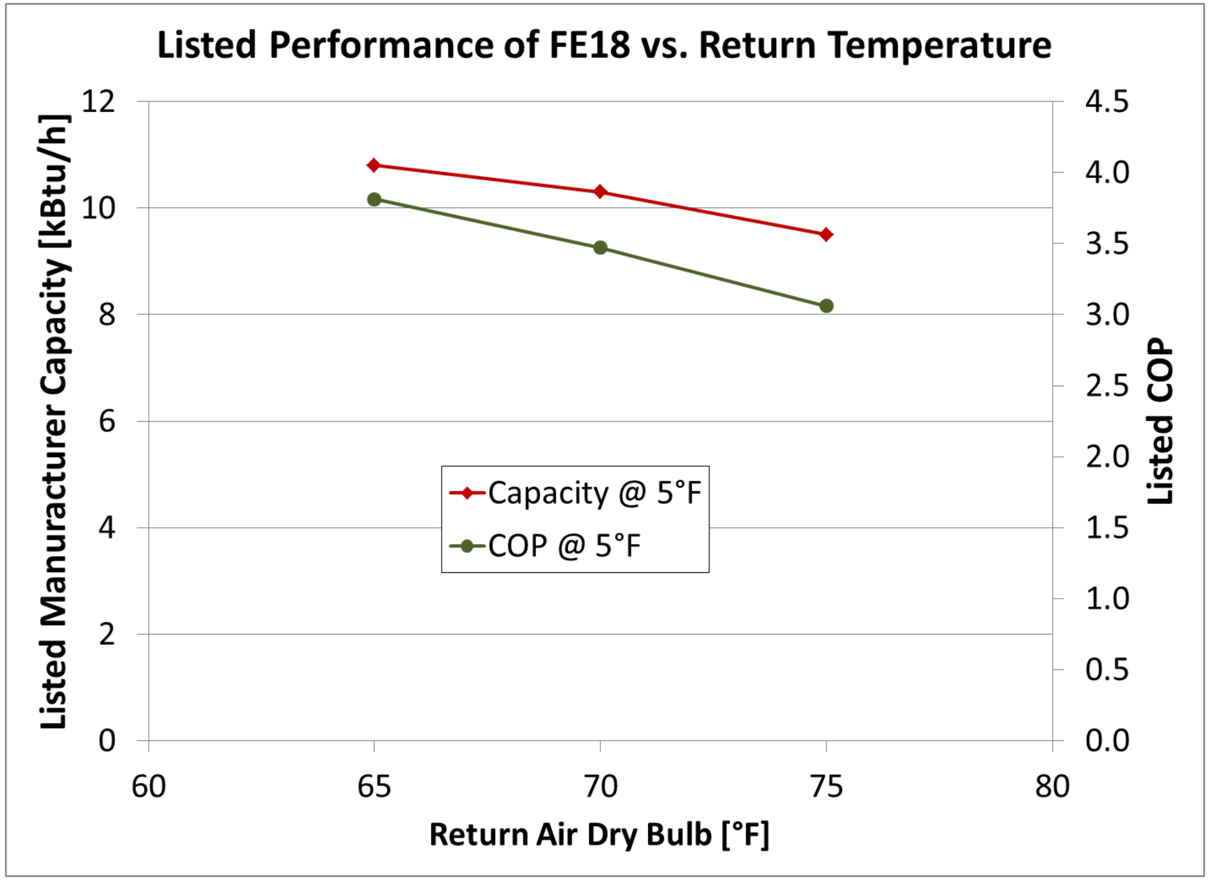
Installation Considerations

Indoor Unit

- Placement of the indoor unit serves as a major driver for a system’s overall efficacy.
  - The ASHP head must be placed so it can circulate air through the entire conditioned space and can provide a uniform comfort level.

Image from Mitsubishi

High Return Temp?



Indoor Unit

- Overflow switch is designed to shut off the equipment served in the event that the primary drain becomes restricted.

Outdoor Unit

- Placement of the outdoor unit is just as critical as the placement of the indoor unit.
  - The ASHP must be placed to allow for unimpeded airflow through the unit (follow manufacturers recommendations)
  - The ASHP must be attached to the bracket and vibration dampers installed.

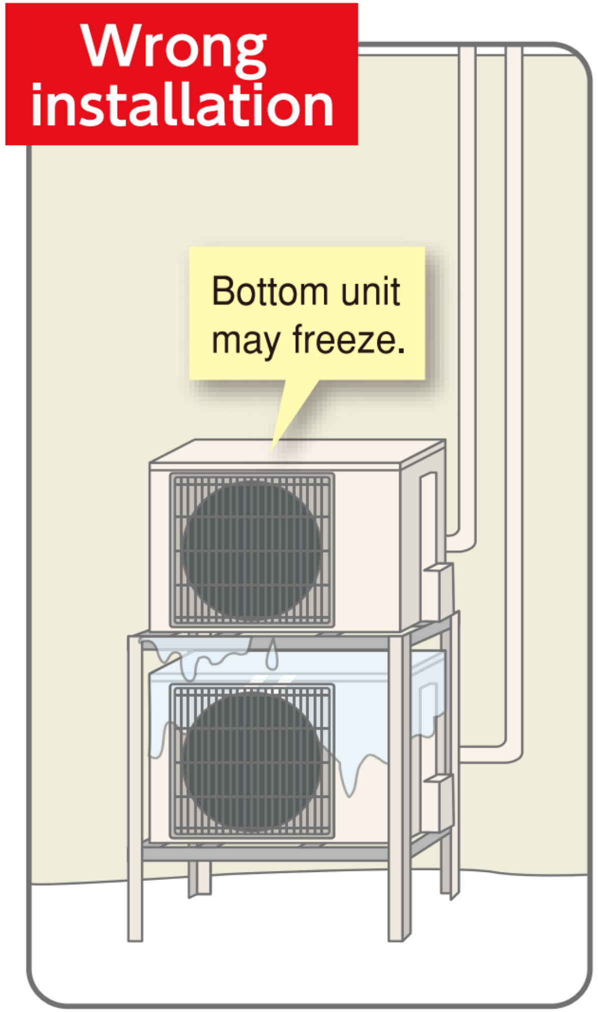
Outdoor Unit

- The outdoor unit, whether its being installed on a pad or a wall bracket, needs to be installed level from side to side and back to front.
- If installing a pad be sure to dig down and compress the soil to prevent settling.

Image Credit: wikiHow

Stacked Outdoor Units

- The defrost function is designed to remove ice build up on the outdoor unit heat exchanger.
- If installing outdoor units in a stacked configuration, ensure the runoff produced from defrost does not drip down on the units below.

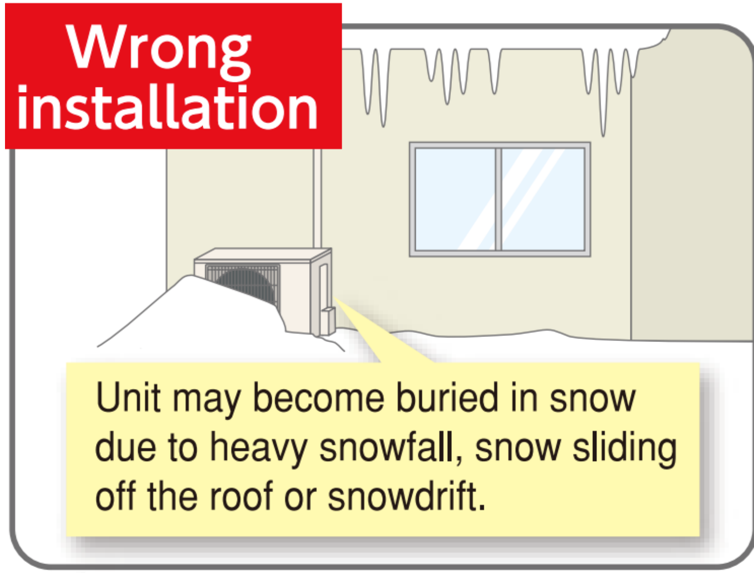


Outdoor Unit Placement

- Do not install outdoor units directly under any drip line from the roof or other overhang that would subject the outdoor unit to falling snowmelt or concentrated rain runoff.

Source: Steven Winter Associates

Snow is a Design Consideration



Line Set Installation

- ACR tubing can be bent easily, preventing the need for additional fittings.
  - Reduce likelihood of refrigerant leaks
- A variety of tubing benders are available.
  - Smaller diameter tubing is easier to bend without a tubing bender.

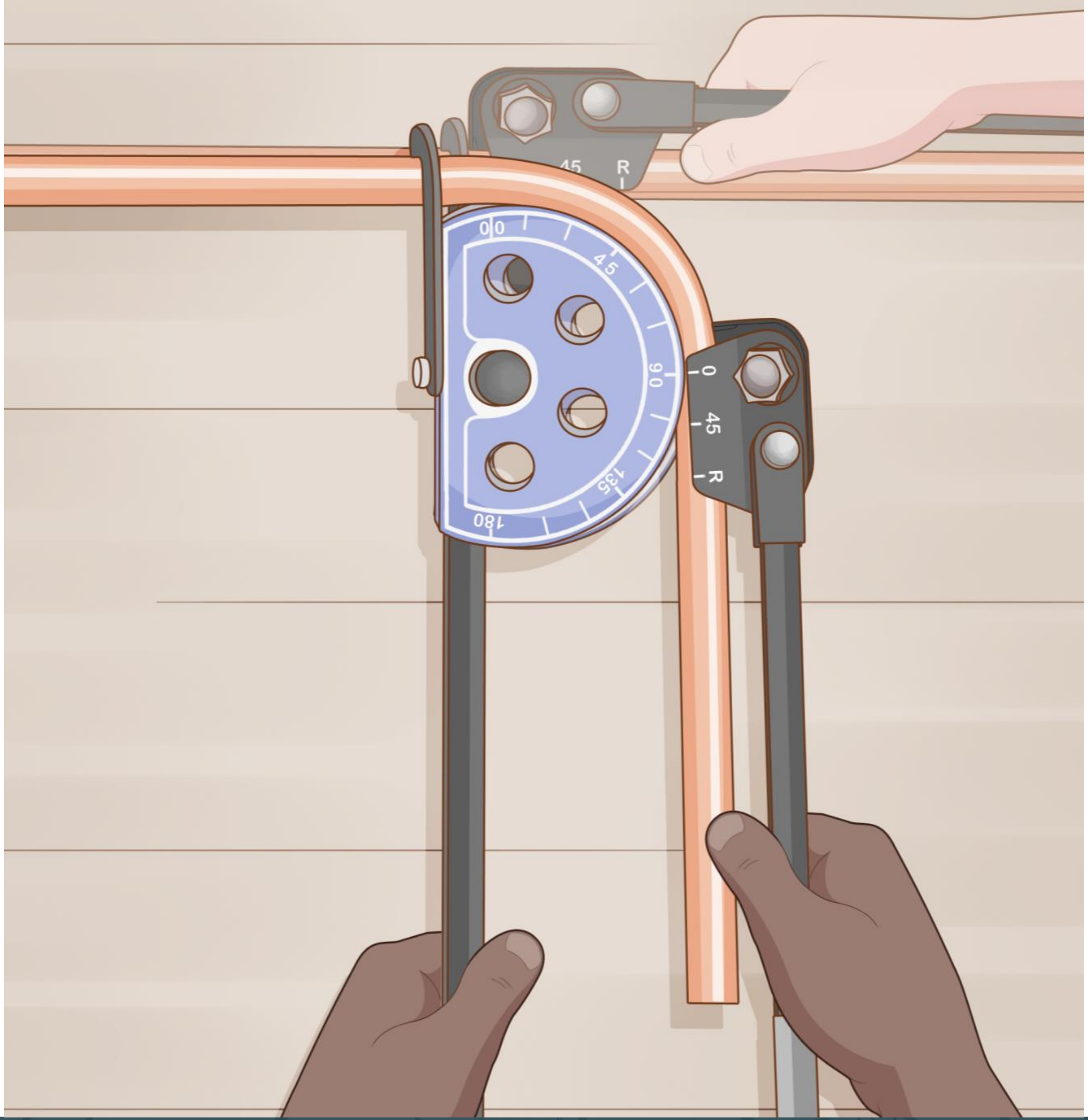
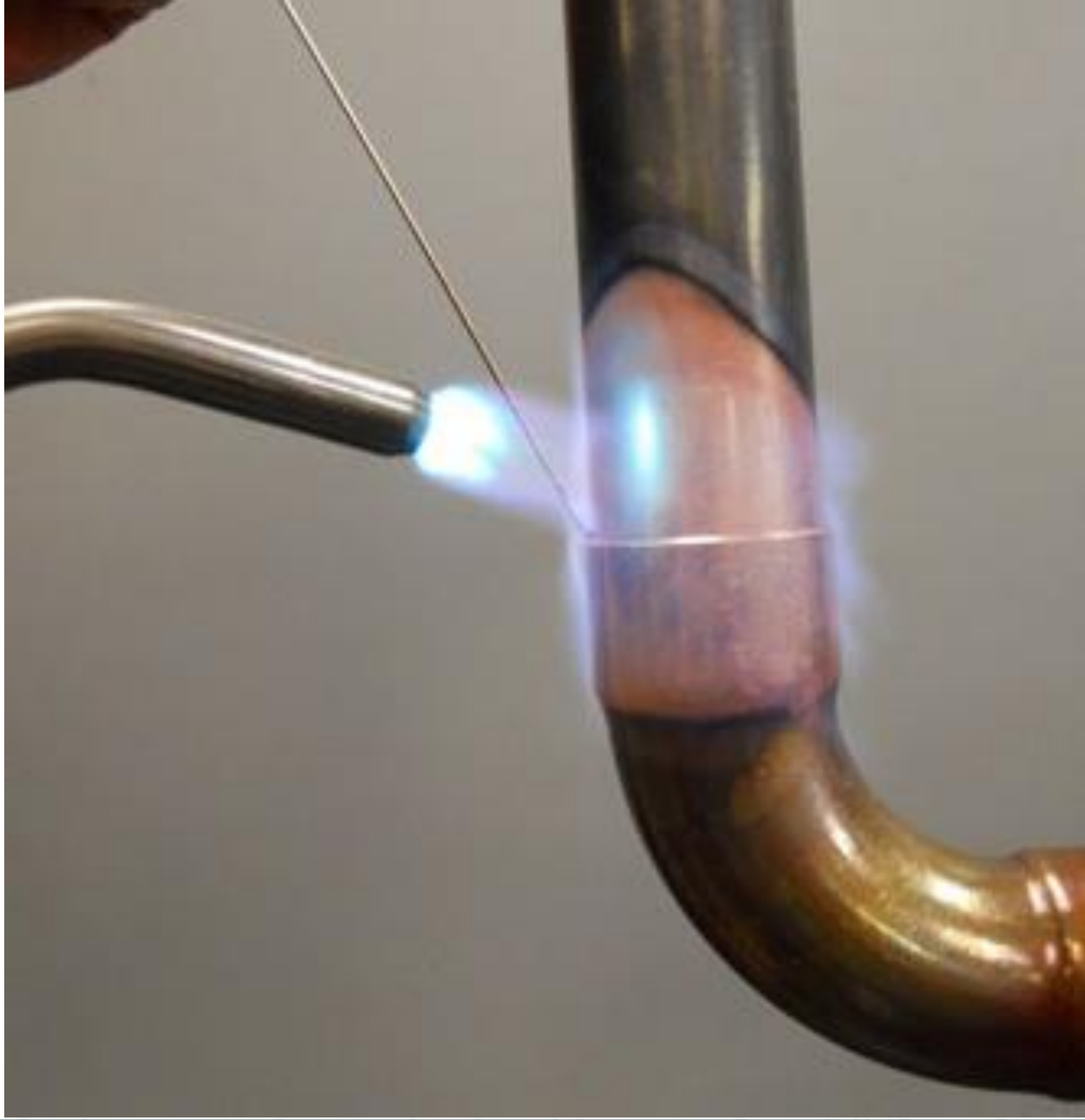


Image Credit: wikiHow

Proper Brazing Techniques

- Improper heating is the primary reason for poorly made joints.
  - The method of heating the joint must get both pieces, the pipe and the fitting to proper temperature before the filler material is applied.

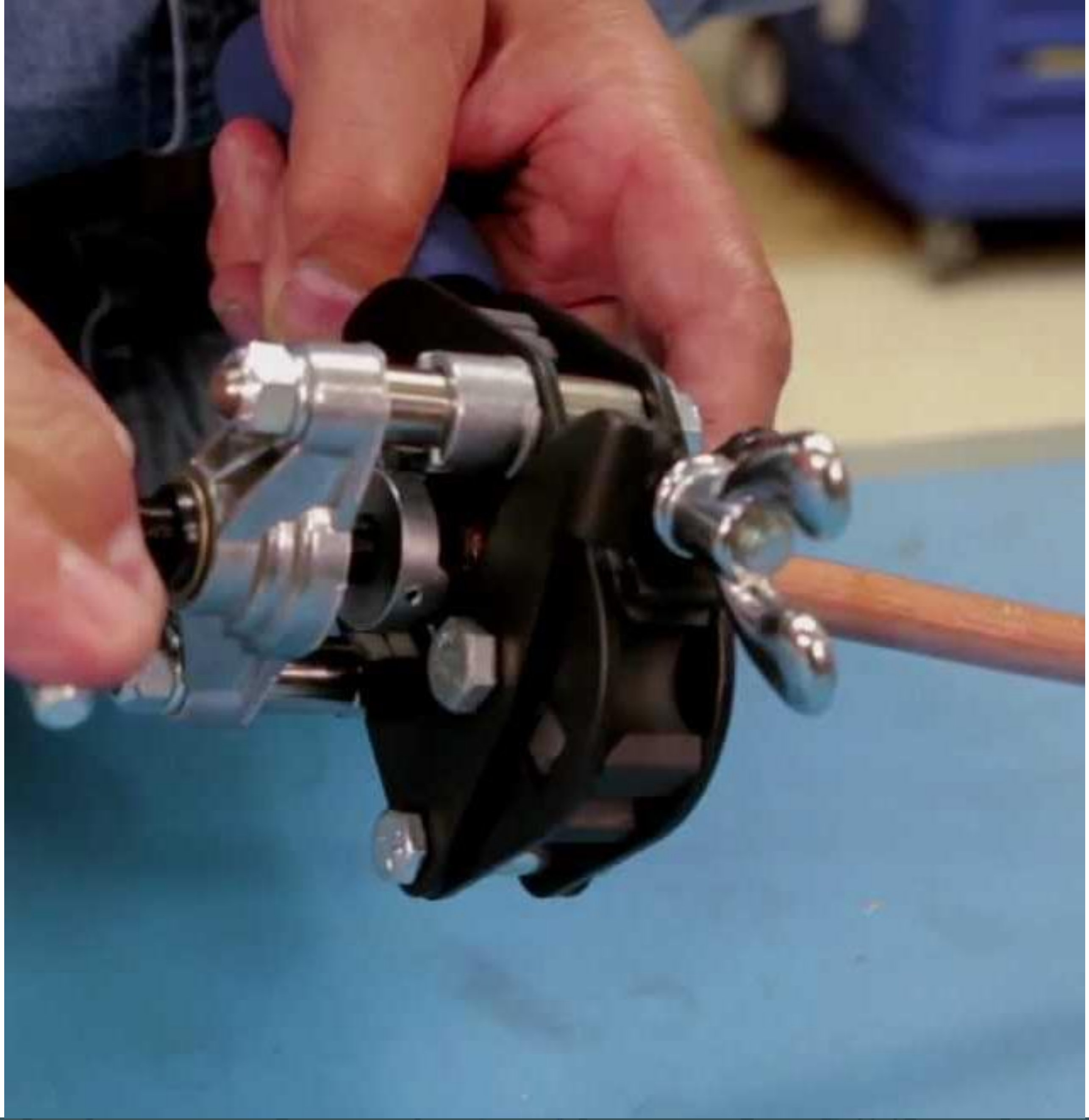


Proper Brazing Techniques

- Purging nitrogen through the copper tubing during brazing.
  - Oxygen in the air combines with copper at high temperature to form a heavy scale (copper oxide).

Proper Flaring Techniques

- Flare joints are the primary mechanical connection between the refrigerant line set and the indoor and outdoors units.
- Ensure the flare is made properly and that the flare nut is not overtightened



Pressure Testing

- Once you have the refrigerant line set properly installed, we need to make sure there are no leaks
- A pressure test with nitrogen can be performed following manufacturers recommendations

Line Set Insulation

- Line set insulation must cover the entire line set to avoid condensation and energy loss.
  - Once insulated the outdoor portion of the line set shall be protected to avoid insulation damage and UV degradation.

Source: Bruce Harley Energy Consulting, LLC

Line Set Insulation

- Once insulated the outdoor portion of the line set shall be protected to avoid insulation damage and UV degradation.

Line Set Installation

- Once the line set is installed, seal the openings with an approved sealant to prevent air movement and pest intrusion.
- A line set cover can be installed to protect the line set and help improve aesthetics

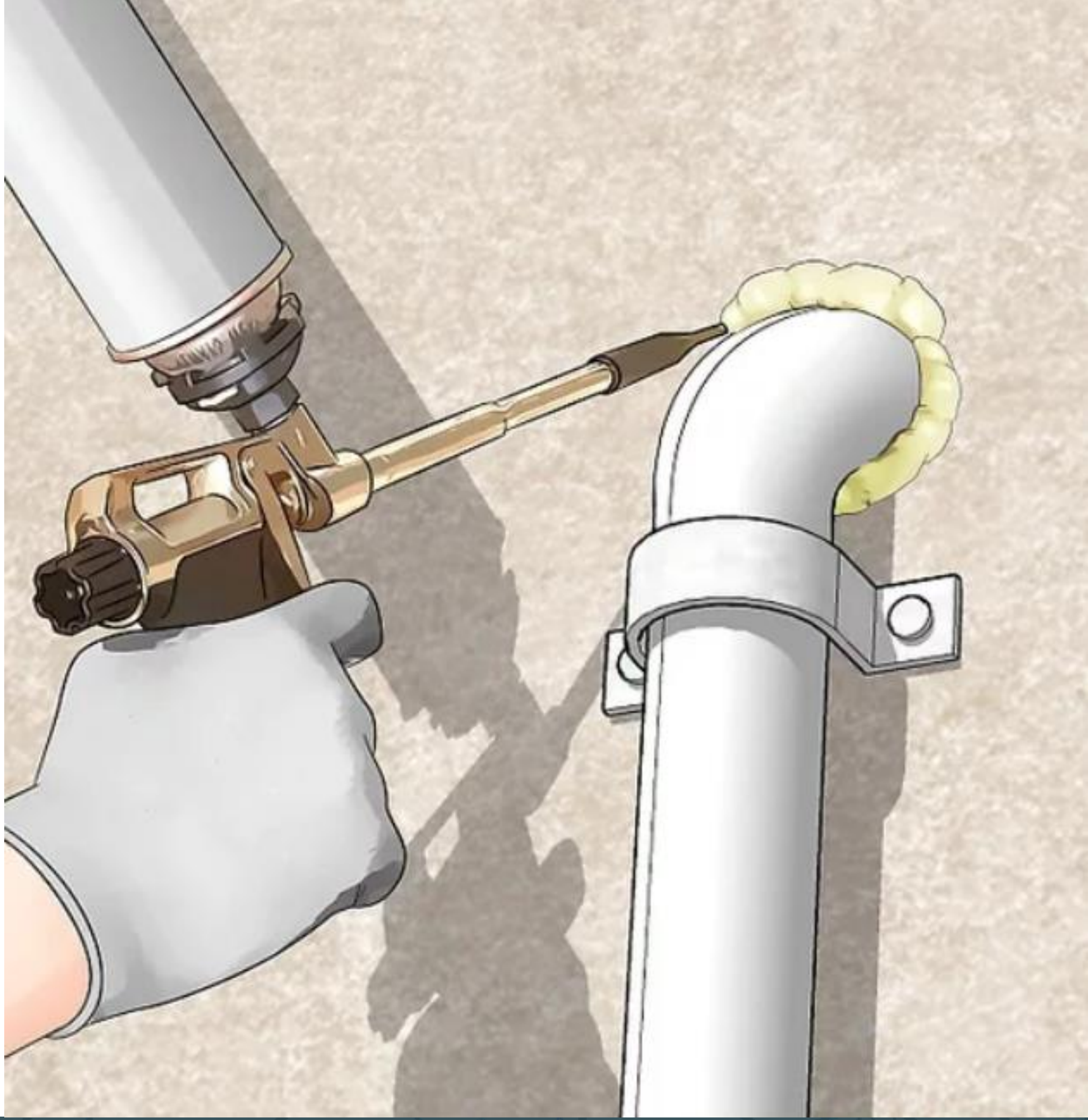


Image Credit: wikiHow

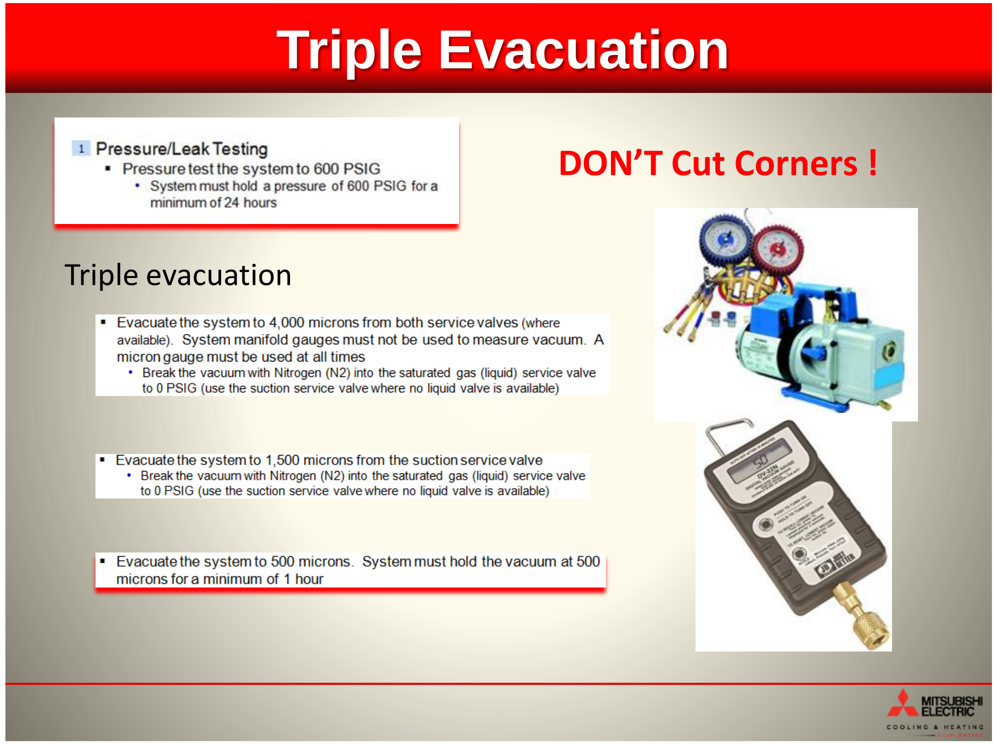
Evacuation

- Micron Scale
- Confirm no leaks
- Confirm no moisture

Evacuate and Charge

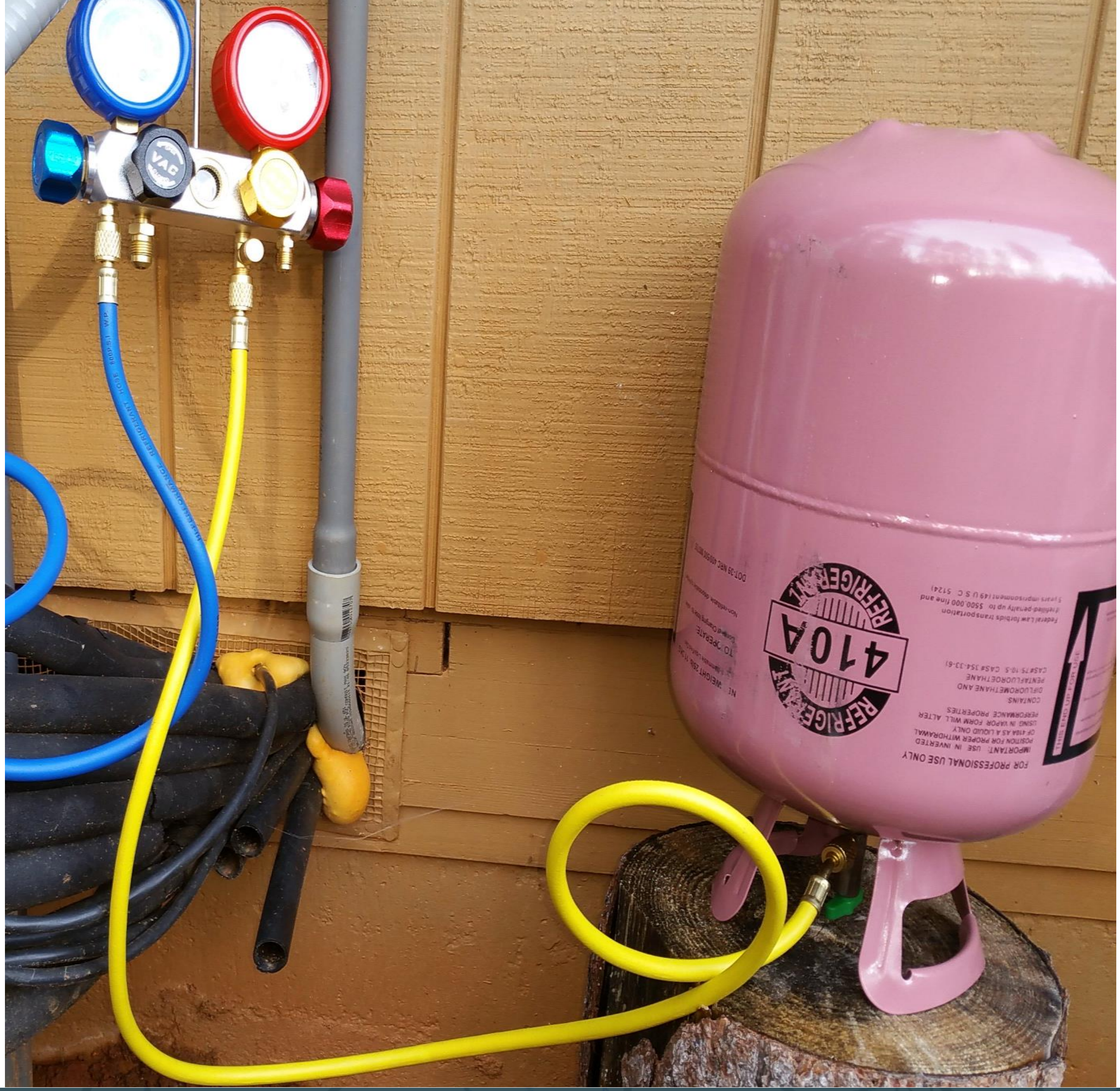
LotBlock N-101

	Chk	NA	Iss
Evac and Charge			
Confirm test pressure at 95 -100 PSI	☑	☐	☐
Confirm CU connected to the correct Apt.	☑	☐	☐
Evacuate to 30" hg and Charge by weight.	☑	☐	☐
0-15Ft 0 lbs-0 ozs	☐	☐	☐



Charging

- We need to determine the volume of refrigerant that needs to be added.
- Measure twice charge once



Wiring

- Ensure that the overcurrent protection device is labeled, and the correct size based on the manufacture's requirements
- Ensure the conductors are the correct size and compatible with the terminals.

Wiring

- A disconnect switch needs to be installed at the outdoor unit to allow for service, and the ability to deenergize the unit in the event of an issue.
- The disconnect switch should be located within arms reach of the service panel of the outdoor unit.

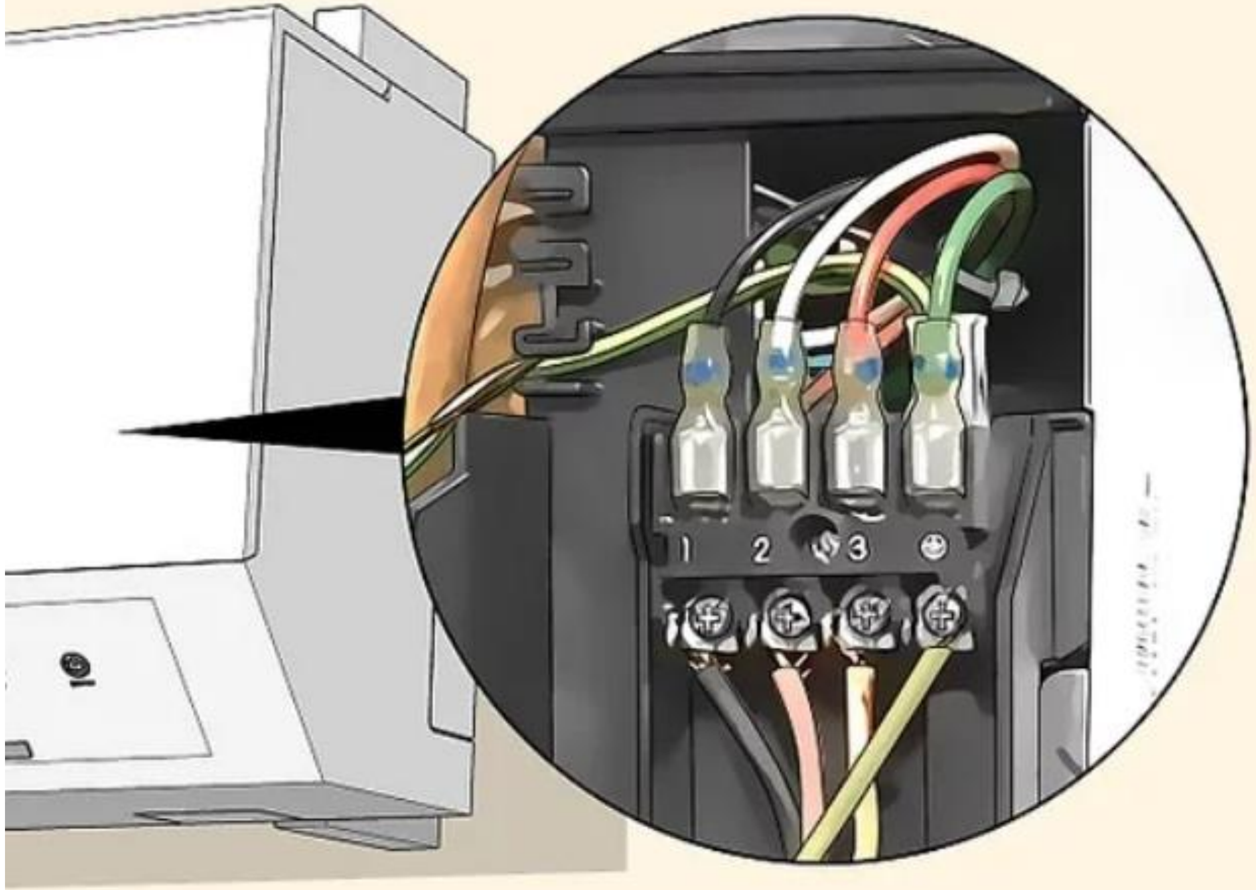
Wiring

- Install the input power and indoor unit wiring at the terminal block.
  - Firmly tighten the terminal screws and ensure the connections are tightly fastened.
- Ensure the system is properly grounded.

Wiring

- The power and communication cable is then connected to the indoor unit(s).
- Ensure that the correct wire is attached to the correct terminal at the terminal block.

Unit	1	2	3	Ground
Outdoor Unit	Black	Red	White	Green
Indoor Unit	Black	Red	White	Green



Wiring

- Install 3-pole disconnect switch, in order to deenergize the indoor unit for service or repair.

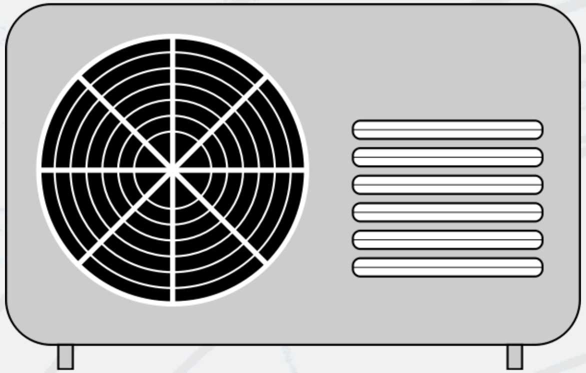
Controls

- Wall-mounted thermostats preferred
  - Instead of remote controls
- Prioritize use of Heat Pump for heating
  - Manually adjust systems
  - Two(+) stage thermostats
  - https://nyserda.ny.gov/qualified-integrated-controls
- Dual-fuel systems typ. have built-in controls

Start-Up

- Verify proper voltage at outdoor and indoor units.
- Perform heating and cooling mode check.
- Record return and supply temperatures at indoor unit(s)
- Test condensate drains

Additional Considerations: Challenges and Solutions



Challenges & Solutions

Challenge: ASHP **Capacity** at Cold Temperatures

Possible Solutions:

- Lower the load
- Use multiple ASHPs
- Use ASHPs to meet part of the load
- Some combination

Challenges & Solutions

Challenge: **Comfort** Supply Air Temperature

- ASHP supply temp ~90-125°F

Possible Solutions:

- Lower the load
- Assess room-by-room loads & comfort concerns
- Use ASHPs to meet part of the load
- Some combination

Central Ducted Challenges & Solutions

Challenge: **Air Volume**, Duct Size (Meeting Load)

Air Flow	Supply Temperature	Heat Delivered
60 cfm	150°F	4,800 Btu/h
60 cfm	110°F	2,400 Btu/h

Possible Solutions:

- Lower the load
- Measure pressure/flows before, modify ducts as needed
- Use ASHP for part of the load

Central Ducted Challenges & Solutions

Challenge: **Duct Leakage** and Insulation

Solution:

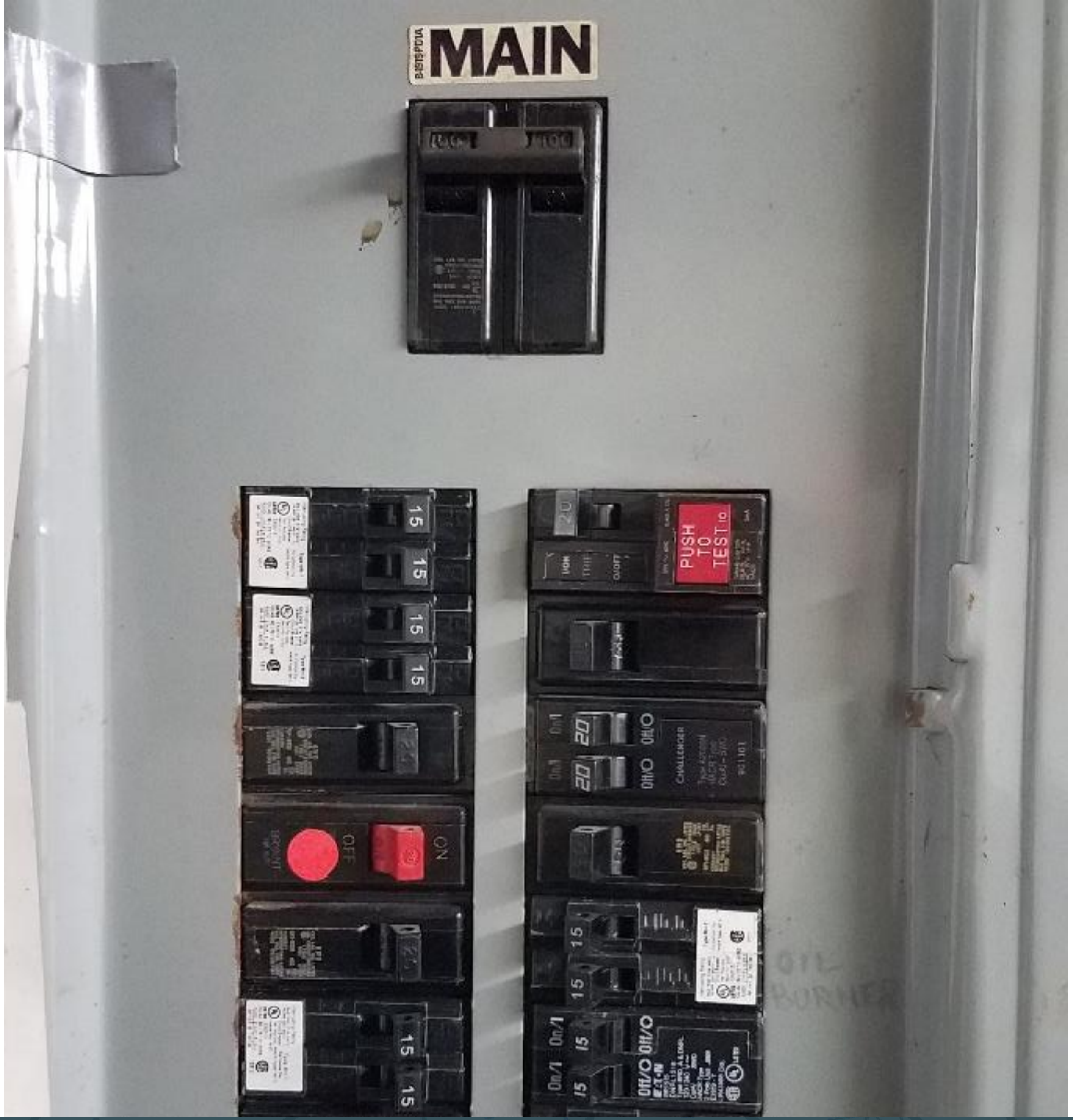
- Insulate and seal ducts!

Challenges & Solutions

- **Challenge**: **Electrical** Capacity

Solution:

- Upgrade the electrical service
- Install a sub-panel



In Summary

- Reducing building loads reduces the size of the heat pump, which improved cost effectiveness, performance, and capacity.
- Reduce refrigerant line lengths and make sure piping is protected from damage
- Ensure units are installed at a height that will ensure performance
- Stay up-to-date with new alternatives

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