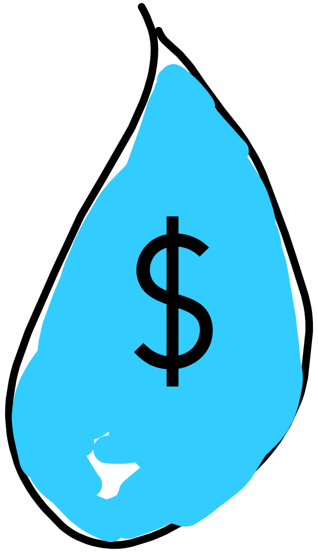
phius con NEW YORK 2021

What Goes In Must Get Out:
What Does a Grain of Water Cost?



Emma Raymont — MaGrann Associates

Kimberly Llewellyn — Mitsubishi Electric Trane HVAC US

MaGrann & Associates:

MaGrann Associates is a pioneer in building science, green certifications, and high-performance building systems engineering. We strive to be leaders in the ongoing development of best practices in the design and construction of the buildings where we all live. We specialize in working with developers, builders and architects to design, build, maintain, and manage their buildings to reduce costs and risks while increasing value and quality, making their multifamily buildings high performing assets .

About Emma:

As Director of Engineering, Emma leads a team of engineers who provide high performance energy efficiency and mechanical design consulting services for new and existing multifamily and mixed commercial use buildings. Emma is a licensed Professional Engineer and an accomplished designer and trainer in HVAC and building science principles for both new and existing construction. She has been responsible for managing the engineering, multifamily & commercial consulting teams for PSE&G, NJCEP and other similar programs, including technical oversight, coordinating internal resources, maintaining quality, developing standards and ensuring customer satisfaction. Emma leads an integrated design process that optimizes the performance and cost effectiveness of projects, including evaluation of existing mechanical systems, design for energy upgrades and post installation measurement and verification. Additionally, she has provided oversight and support for numerous quality assurance and evaluation projects in both residential and commercial markets since joining MaGrann Associates in 2002. Ms. Raymont has dual degrees in Civil and Architectural Engineering.

Mitsubishi Electric Trane US:

Mitsubishi is the global market leader for high efficiency inverter driven air source and water source heat pumps. The company holds itself to the highest standards of environmental stewardship and social accountability and is frequently awarded for innovations related to environmentally sustainable advances in manufacturing and development of more efficient technologies.

About Kimberly:

Kimberly Llewellyn is a high performance building and emerging market specialist. She is the technical lead of Mitsubishi Electric's Performance Construction Team and holds a Master of Science degree in Environmental Engineering from Columbia University. Kimberly also has served as a voting member on ASHRAE Technical Standard Committees 62.2 (Residential Ventilation and Acceptable IAQ) and 227P (Passive Building Design) and is a PHIUS certified CPHC. Motto: "Balance theory and practice, keep your boots dirty, hold skilled trades in high regard and refuse to gloss over inconvenient field realities."

McGrann & Associates:

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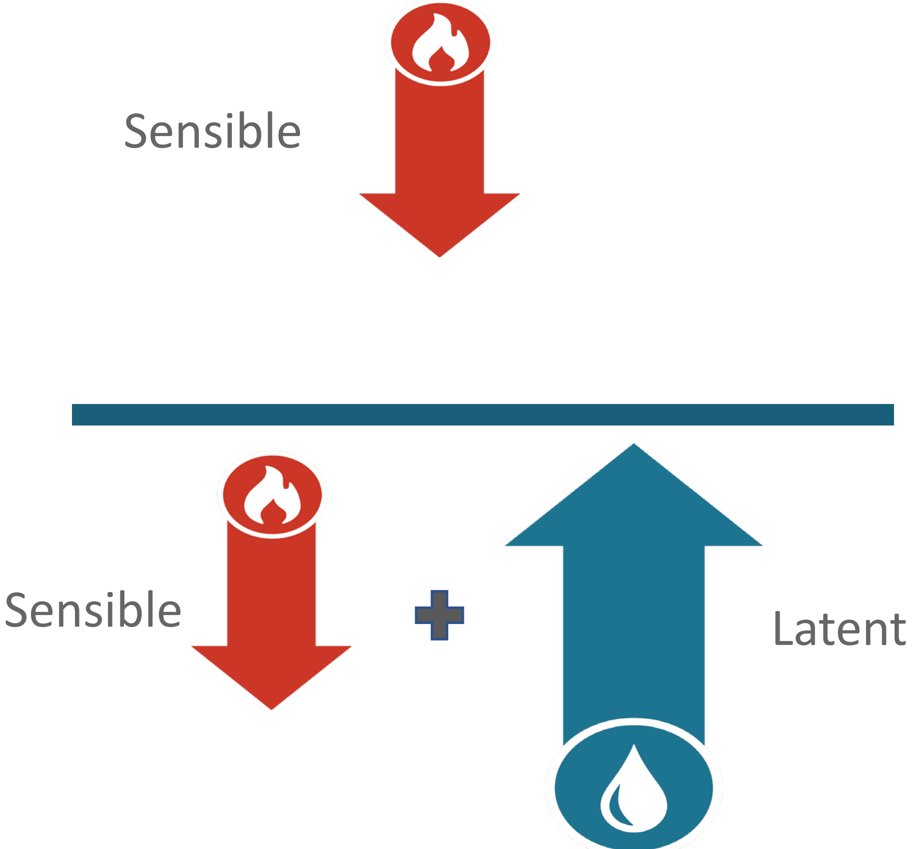
WHAT MAKES MULTIFAMILY LOADS DIFFERENT? (Just Checking)

Lower Sensible Gains

Higher Occupancy Density

Higher Internal Gain Density



AND WHAT ABOUT PH MULTIFAMILY?

Even Lower Sensible Gains

Ventilation Requirements

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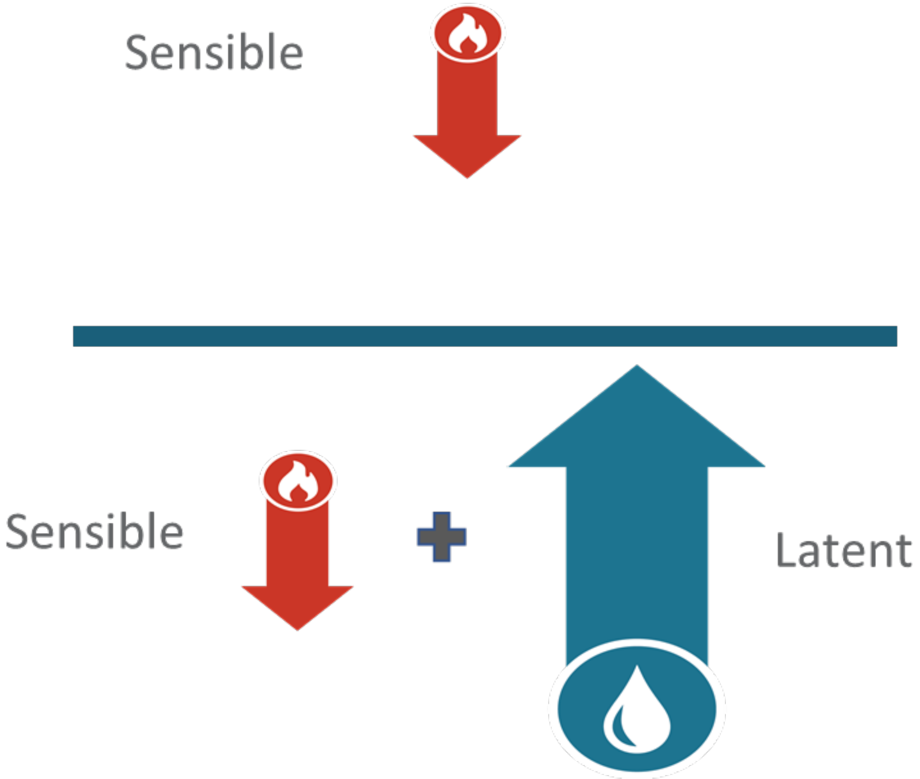


Name Those Equations

$$\frac{\partial \rho}{\partial t} + \nabla \cdot (\rho v) = 0$$

ρ = density

t = time

∇ = divergence

v = flow velocity field

Lavoisier. Engraved by François Séraphin Delpech, after a drawing by Belliart, after the painting by Jacques Louis David.

Science History Institute/Gregory Tobias

$$\Delta U = Q - W$$

ΔU = change in internal energy

Q = heat added

W = work done by the system

Julius Robert von Mayer
(1814 – 1878)

James Prescott Joule
(1818 – 1889)

Hermann von Helmholtz
(1821 – 1894)

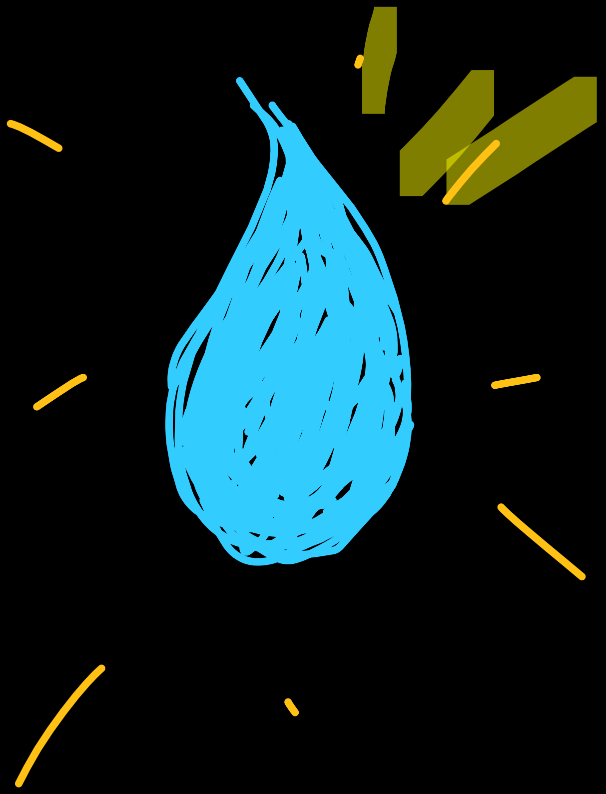
$$E = mc^2$$

E = energy

m = mass

c = the speed of light

Water Neither Created Nor Destroyed Spontaneously



Respiration

Showers, Cooking

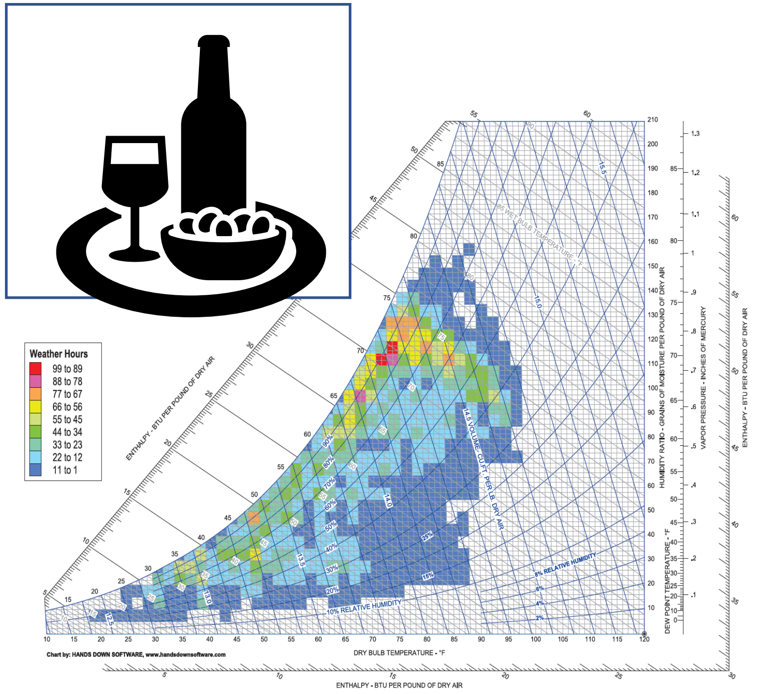
Ventilation ★

Condensate ?

What Comes In ...

Must Go Out ...

No Such Thing As A Free

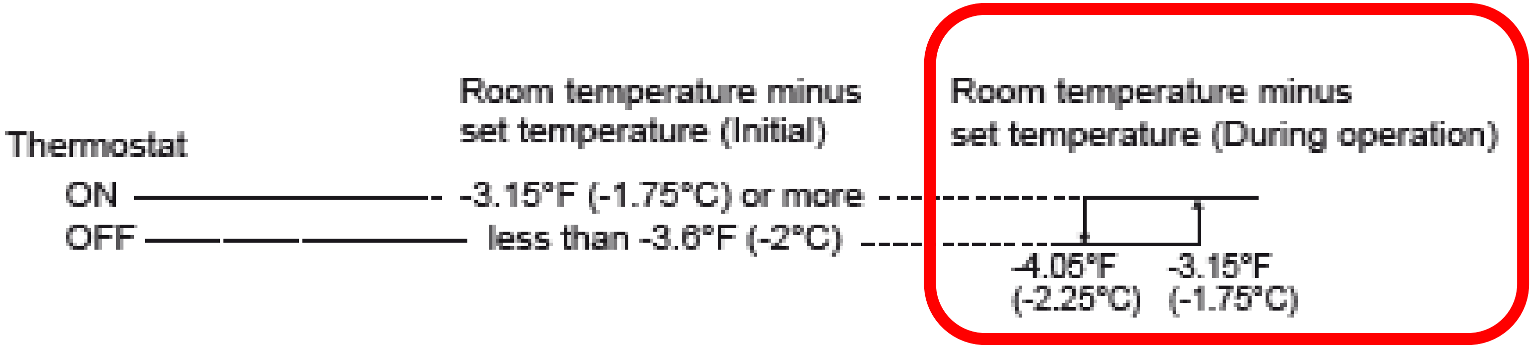


Psychrometric Lunch

So, how do we get water out?

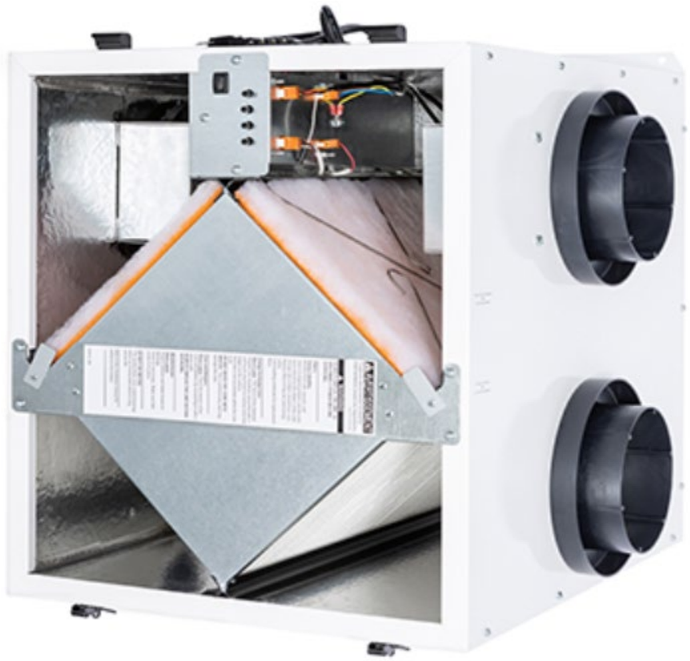
Indoor Unit Cooling Coils- What Are They Capable Of?

If You Don't Have A Sensible Load



They All Remove Moisture By Over-Cooling the Air

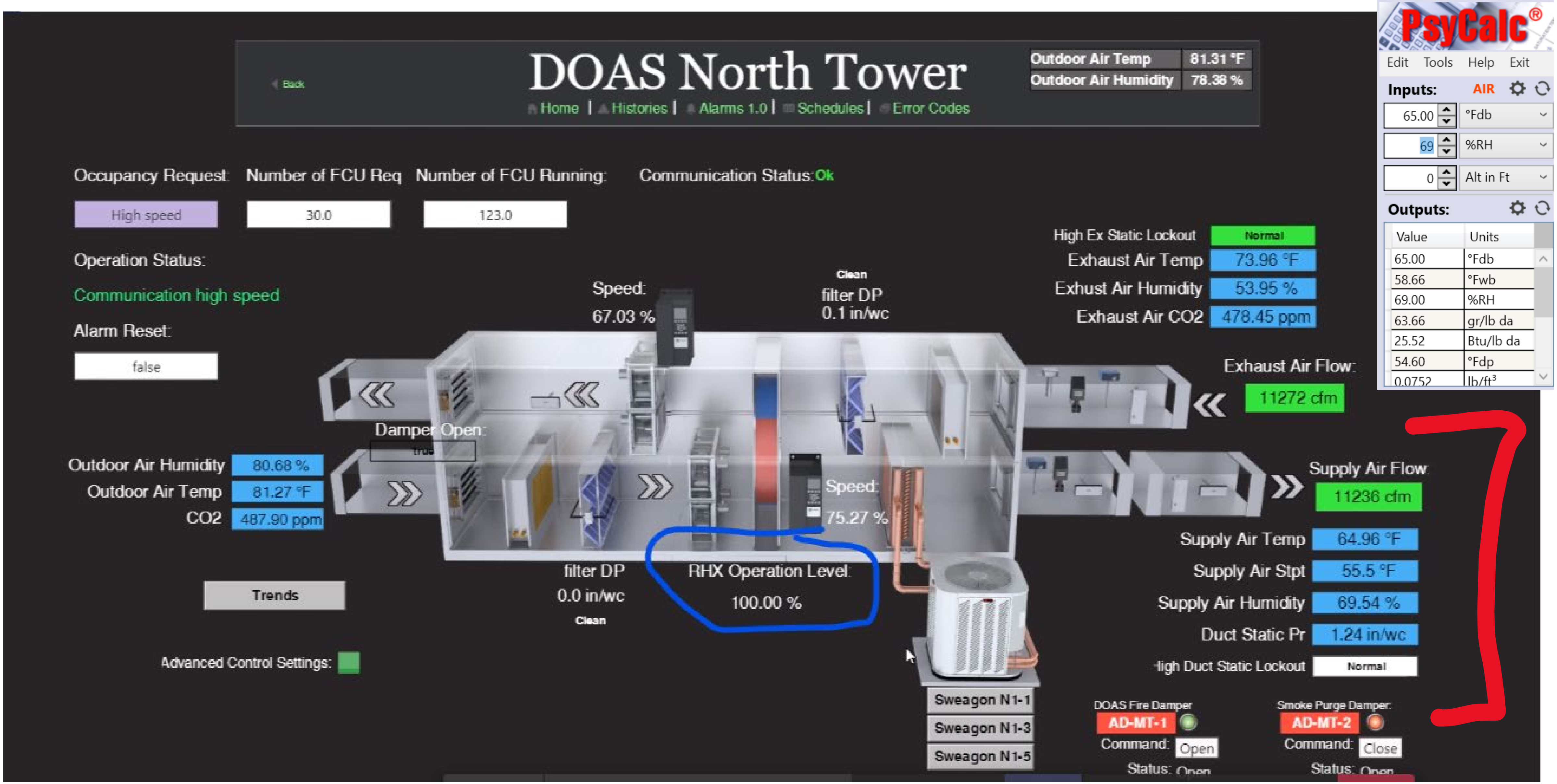
30-50% Latent Load Reduction



Heating Operating Conditions*

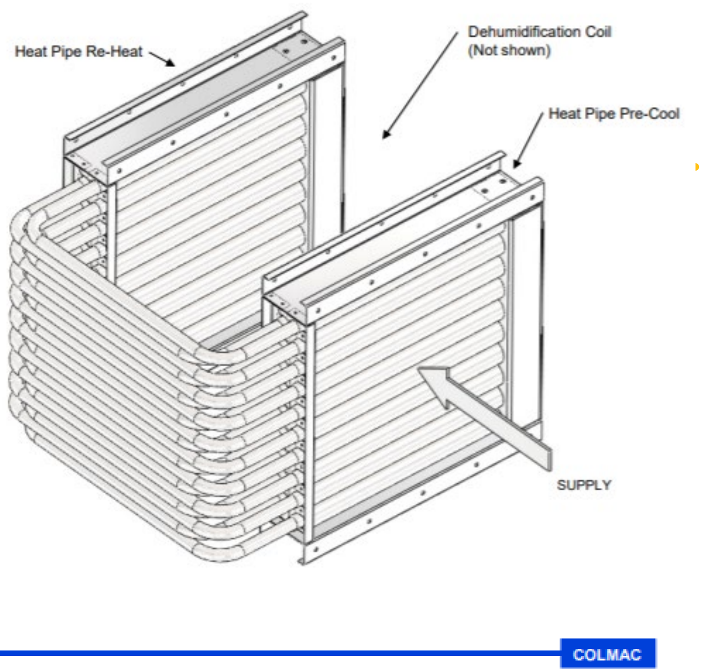
Temp Mode	°C	°F	Net Airflow (L/s)	Net Airflow (cfm)	Power Consumed (Watts)	SRE	ASRE	Latent Recovery / Moisture Transfer	TRE	ATRE	VLTVRF Supply (%)	VLTVRF Exhaust (%)	Very Low Temp Airflow Imbalance (%)
HEATING	0	32	42.0	89	44	80.0	83	0.64					
COOLING	35	95	42.0	89	44				63	71			

Dehu/Cooling Coils Help- Notice the SA Temp

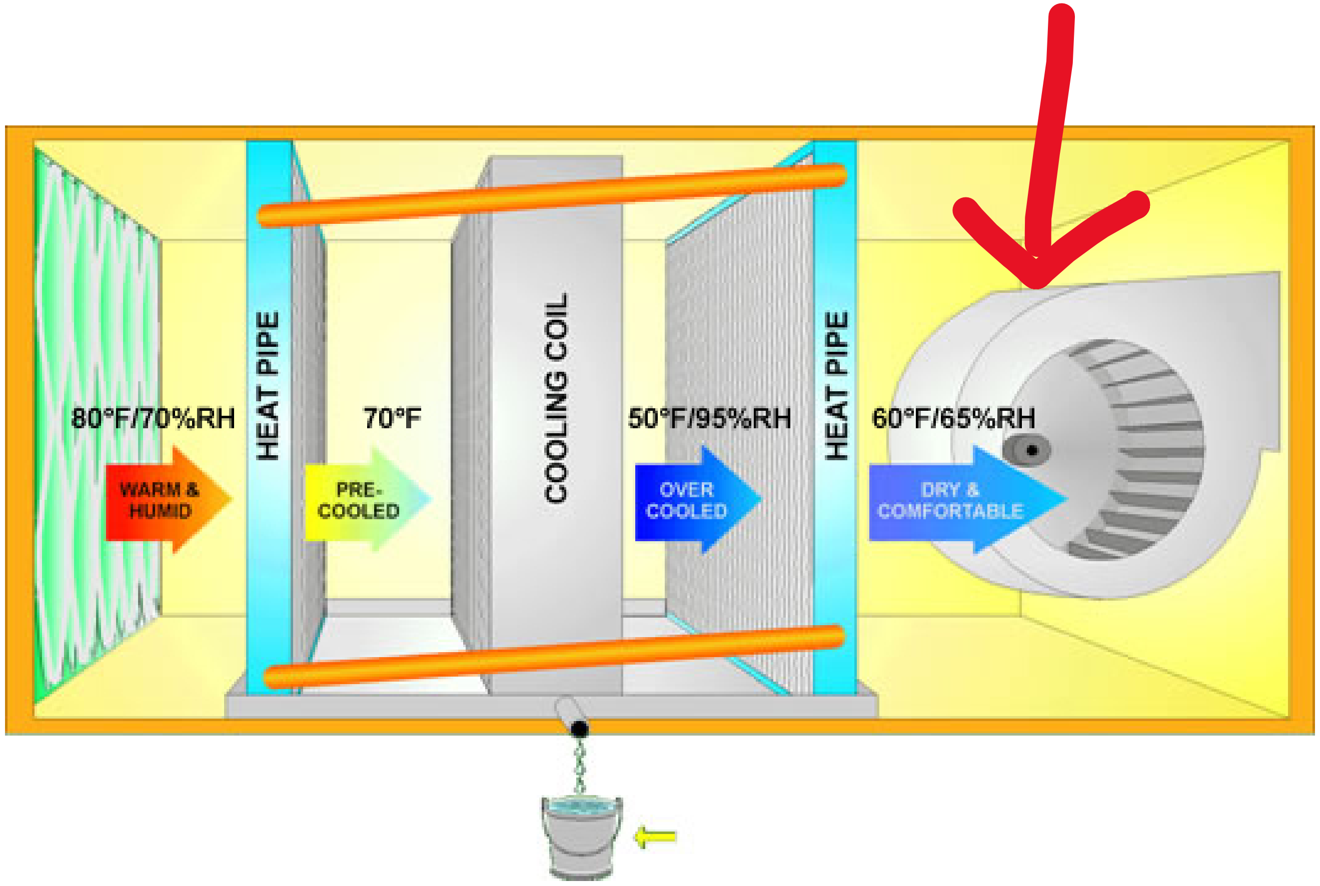


Heat Pipes Passive Help- Notice the SA Temp

Figure 5
Wrap-Around Heat Pipe



4.3.8. The Colmac "Enhanced Dehumidification" heat pipe coil is designed to be a sturdy, reliable unit. Individual "U" tubes are welded to each section of the heat pipe coil to ensure sound construction. Moreover, the individual tubes ensure that there is even distribution of working fluid in all heat pipes. Connections between the heat pipe sections are compact and are located opposite to the dehumidification coil connections. The heat pipe coil can be sized either to closely wrap around the coil or to allow space between it and the cooling coil.



http://www.heatpipe.com/engineering-manual/heat-pipe-principle-and-applications/

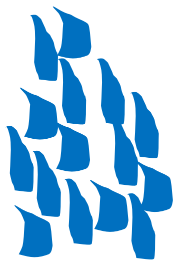
So, When Do You Need This?

Or This?

Dehumidifier

Cooling and Reheat Coils

Humidity Ratio Grains/Lb da



Small Drip of H_2O

~7,000 Grains = 1 Pint

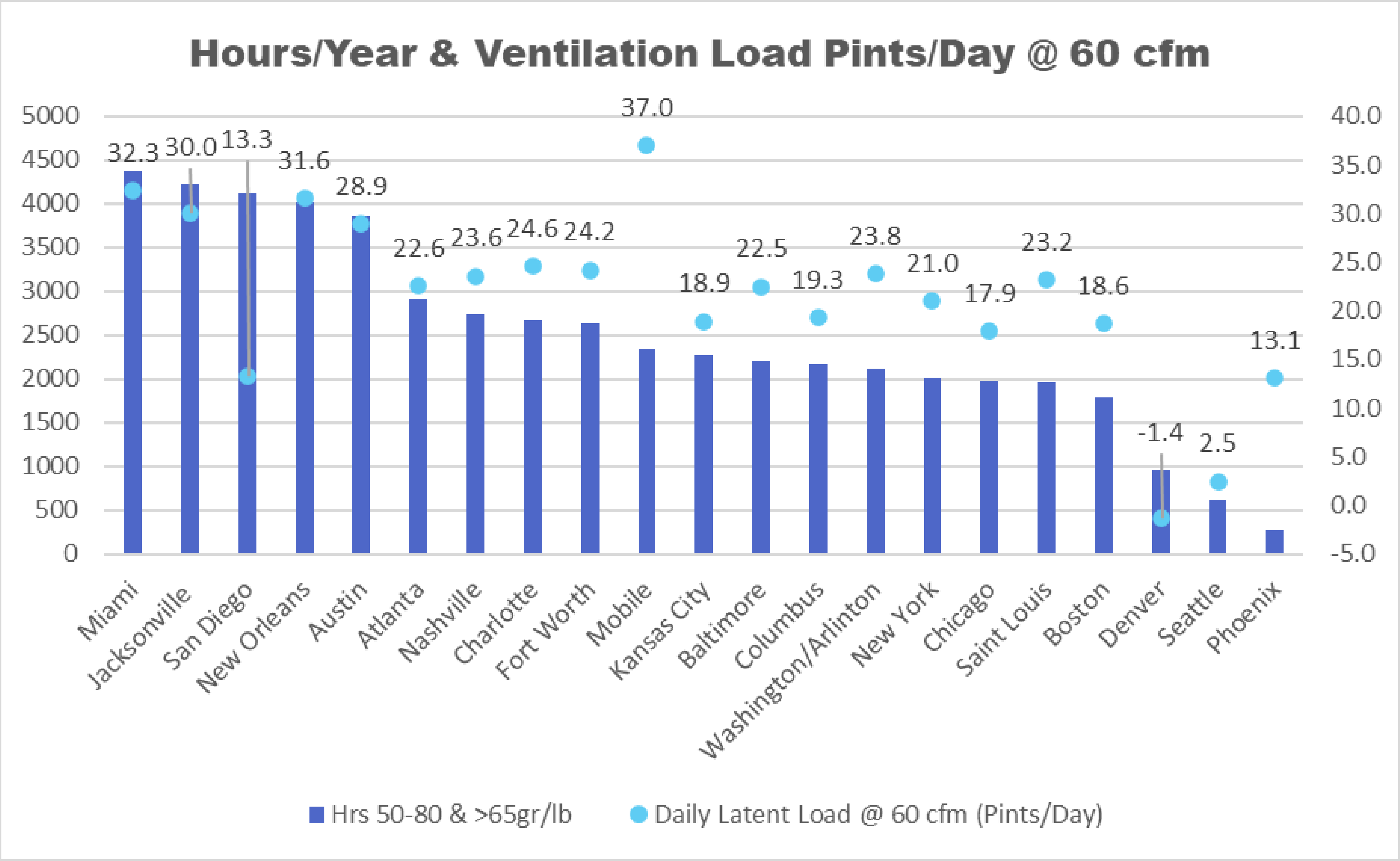
1 Pint= ~1,000 Btu/h

Humidity Ratio Describes the Amount of Water contained in 1 Lb of Dry Air at Standard Conditions

Ventilation Latent Load Analysis & Example: 700 ft², PH Apt [75F DB, 50% RH]

Step	Explanation	Calculation	Example
Step 1 Analyze Annual Hourly Humid Partial Loads for a Location	In most places in the US, the highest humidity conditions occur when DB temperatures are more moderate	Create Weather Bin Using TMY3 Data 55-80˚F (13-27 ˚C) DB and >65 Grains/lb da= Partial Load Hours/Year Avg DB & Humidity Ratio	Arlington VA/DC 2,118 Hrs/Yr 70 ˚F DB 91 grains/lb da
Step 2 Find the difference between Avg Humid, Partial Load Conditions and Interior Design Conditions	Air introduced into the house via ventilation or infiltration that is over the design condition of 65 grains/lb da (9.27 g/kg da) results in additional latent load	Humidity Ratio OA – 65 grains/lb da (9.27 g/kg da) Convert to absolute humidity grains/ft³ or g/m³	91 grains/lb da - 65 grains/lb da (9.27 g/kg da)= 26 grains/lb da 1.93 grains/ft³
Step 3 Determine Continuous Ventilation Rate	PHIUS Requirement	Fill In	60 cfm
Step 4 Use the Moisture Density and the Ventilation Rate to Determine a daily Ventilation Latent Load	This ventilation latent load represents average rates during climatic conditions when there is little call for cooling	Ventilation Rate x Absolute Humidity OA x time conversions= Daily Ventilation Latent Load	60 cfm x 1.93 grains/ft³ x 60 min x 24 hrs / 7,000 grains/pint= 24 pints/day

How Much Is Coming In?



Building in a Swamp

Hillandale Gateway – Hillandale, MD

Program:
- Mixed Use, Mixed Income
- 454 Apartments
- 4 Retail Sites

Team:
- Duffie, HOC, PS Ventures
- CPJ, MaGrann, NK Arch, Pando, Prescient, SA Miro, Torti Gallas

Hillandale Gateway – Basis of Design

Goals:

- LEED H - Platinum
- ENERGY STAR
- PHIUS
- ZNE (Senior Bldg only)

HVAC Systems:

- Heat Pumps Htg/Clg
- ERVs for Ventilation

DHW:

- Heat Pump Water Heaters

HVAC

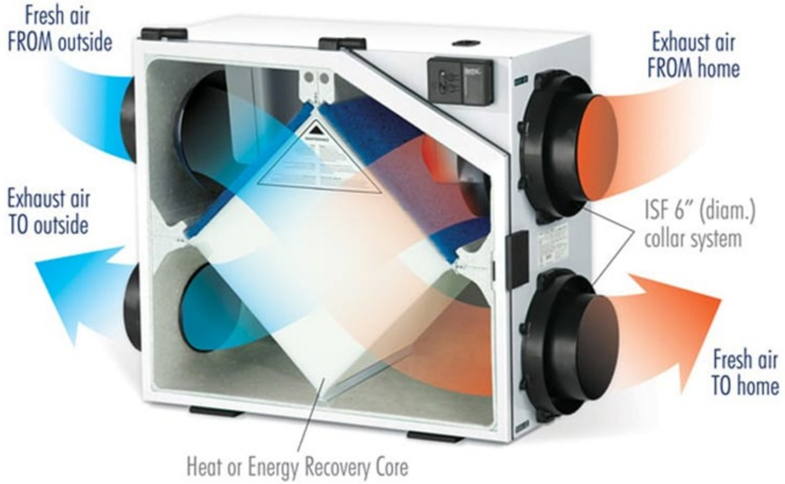
H & AC

- Heating
- Air Conditioning

H & AC	V
Intermittent	Continuous
Individual	Semi-Central
Managing Latent Loads	

V

- Ventilation



Typical Latent Loads

- Typical SF load….

Building Loads				
Total Heating Required Including Ventilation Air:	91,885	Btuh	91.885	MBH
Total Sensible Gain:	43,231	Btuh	81	%
Total Latent Gain:	10,244	Btuh	19	%
Total Cooling Required Including Ventilation Air:	53,475	Btuh	4.46	Tons (Based On Sensible + Latent)

- Typical Apt. load….

Building Loads				
Total Heating Required Including Ventilation Air:	13,961	Btuh	13.961	MBH
Total Sensible Gain:	7,001	Btuh	74	%
Total Latent Gain:	2,489	Btuh	26	%
Total Cooling Required Including Ventilation Air:	9,490	Btuh	0.79	Tons (Based On Sensible + Latent)

PH Apt. Latent Loads

- 1 Bedroom Unit Load Variations

Unit Type – 1B/1B	Sensible Loss (BTUh)	Latent Gain (BTUh)	Sens Gain (BTUh)	Sensible %
East	4,534	1,674	5,652	77%
North	4,534	1,674	3,190	66%
South	4,534	1,674	4,031	71%

INCLUDES VENTILATION LOAD

Calculating Ventilation

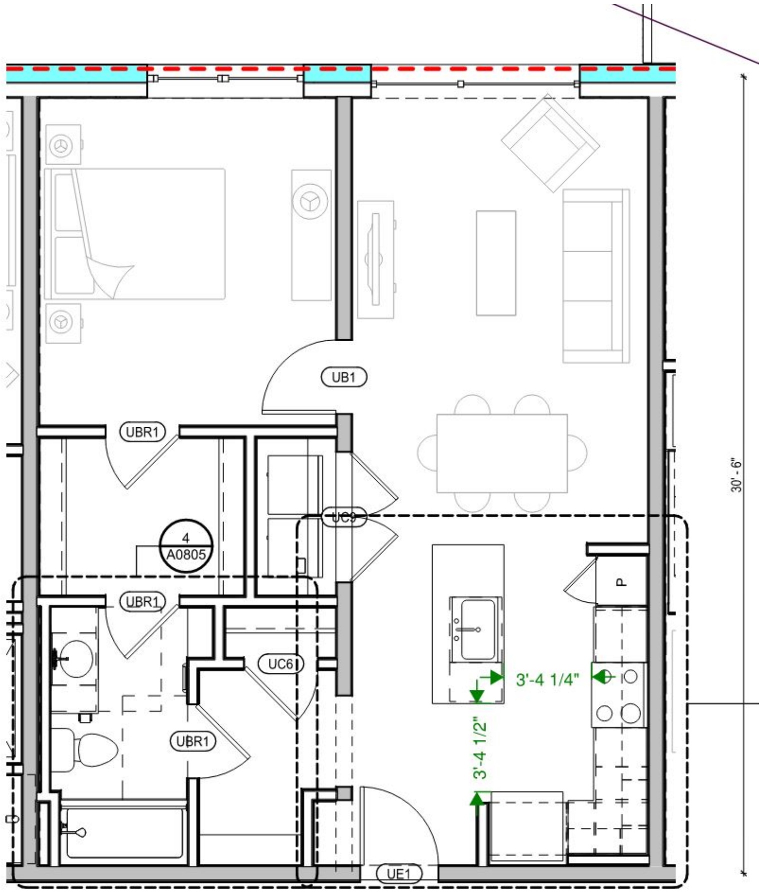
- Code, Program Rqmts – Use Max

Ventilation Loads

- 1 Bedroom Unit (intermediate floor, interior)

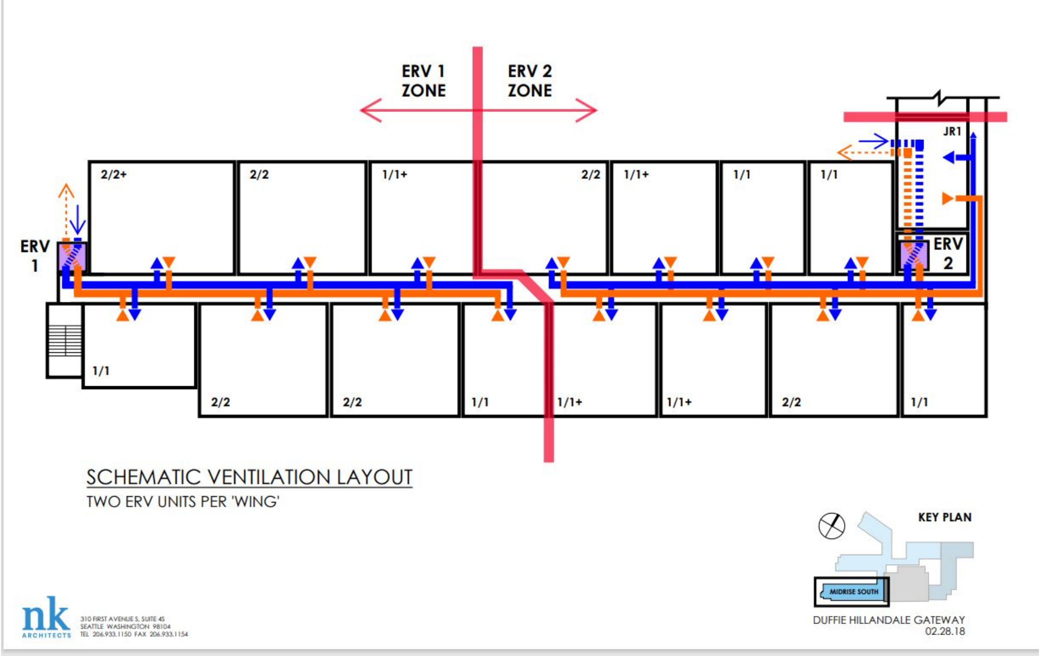
Unit Type – 1B/1B	Sensible Loss (BTUh)	Sensible Gain (BTUh)	Latent Gain (BTUh)
Ventilation (45 CFM)	2,839	930	1,098
Total	4,534	5,652	1,674
%	**62.6%**	**16.5%** *	**65.6%**

* Changes with orientation

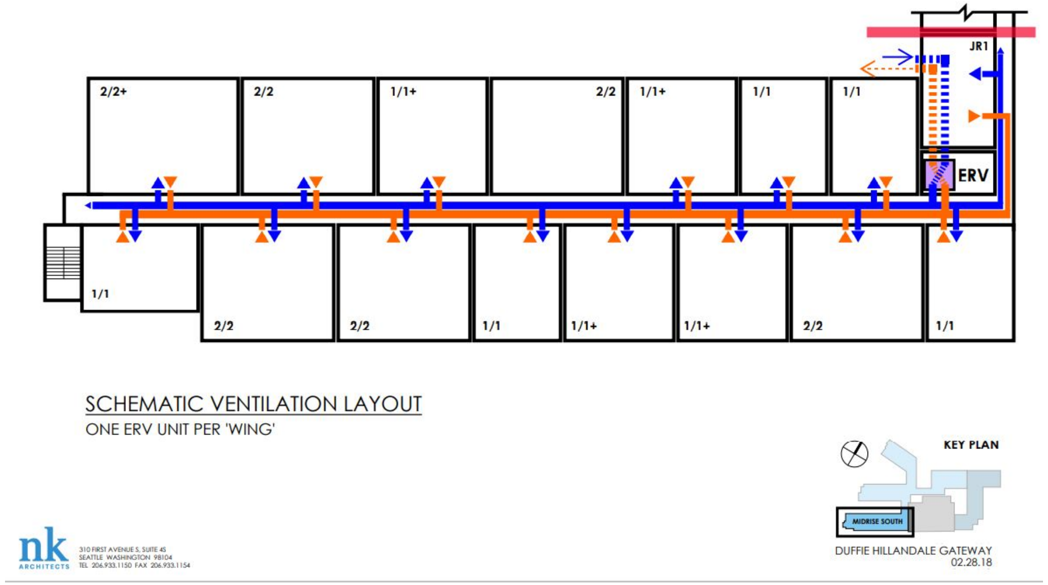


Ventilation Options

- Smaller ERVs

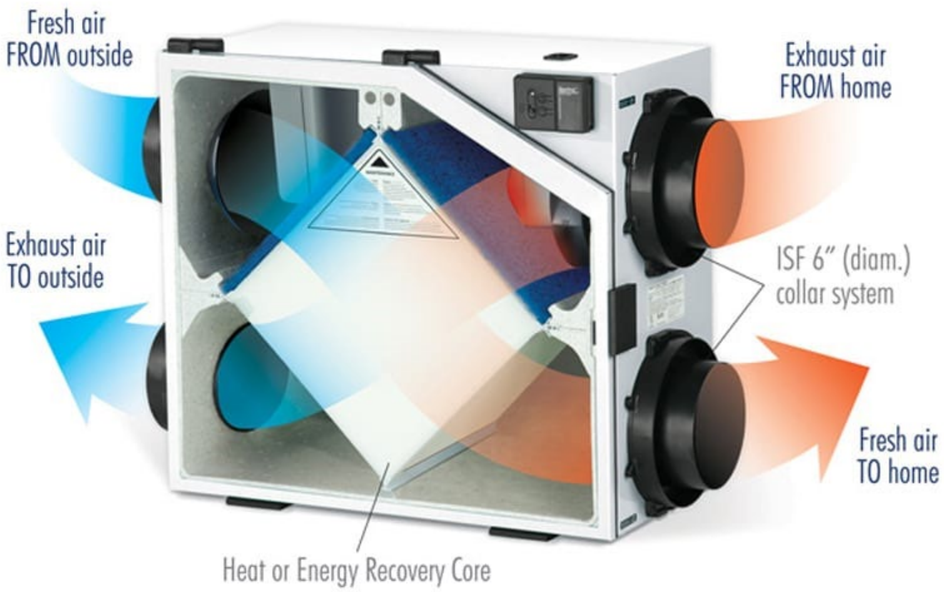


- Larger ERVs



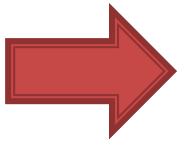
Passive House Ventilation

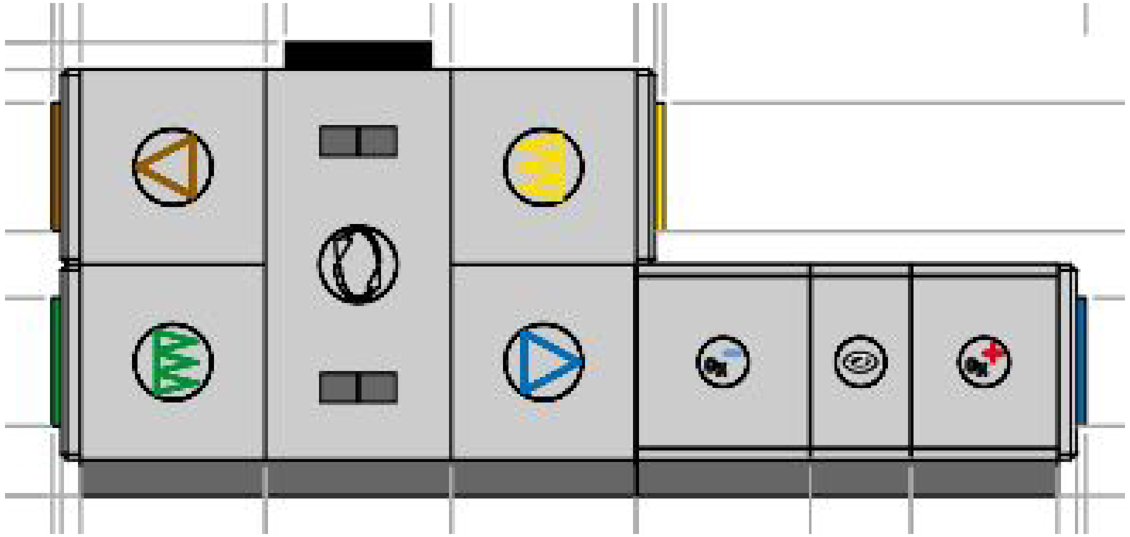
- Use balanced ventilation w/ERV



Ventilation Systems

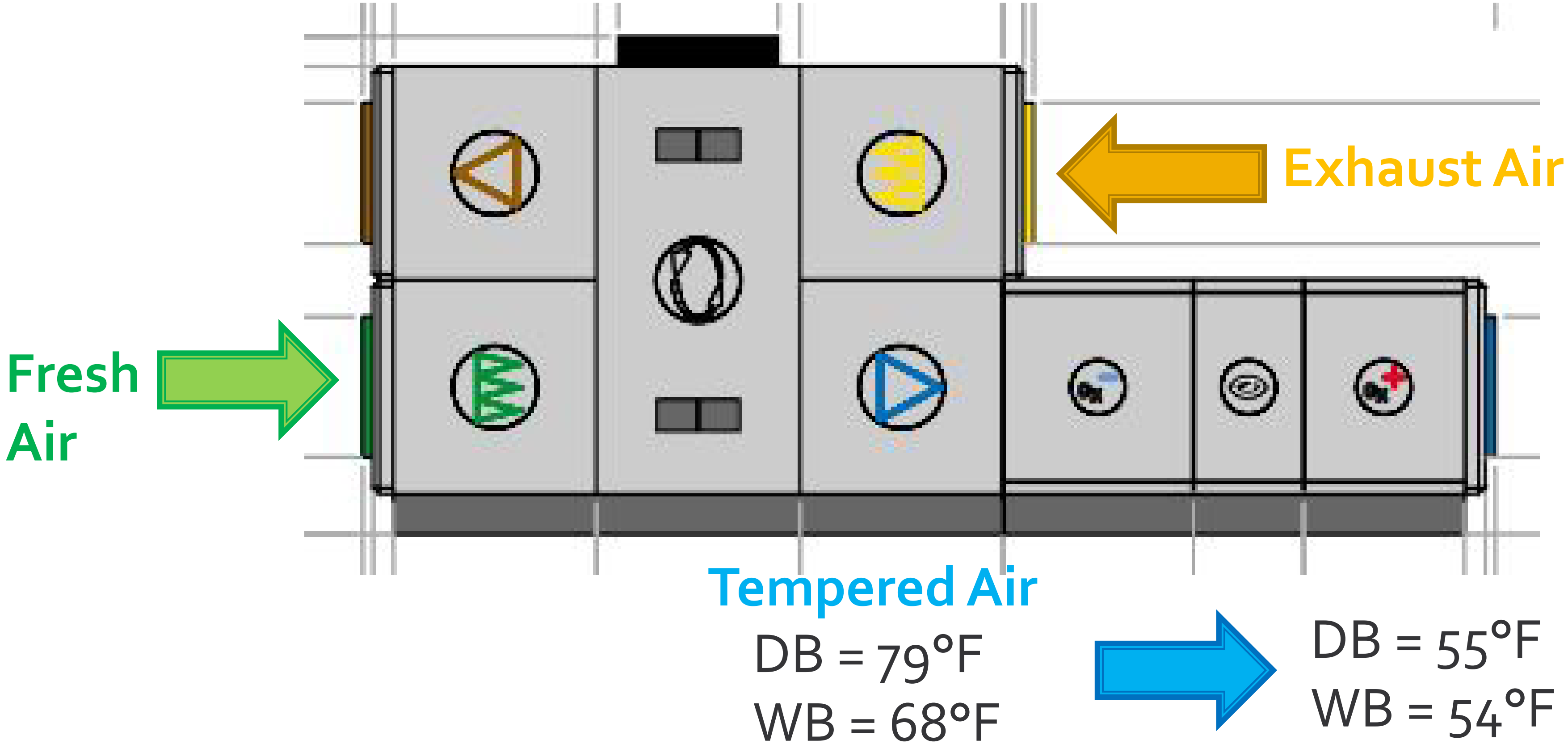
- Fully Condition Ventilation Air





Ventilation Systems – Fully Conditioned

Step 1 - Add a Heat Pump Coil

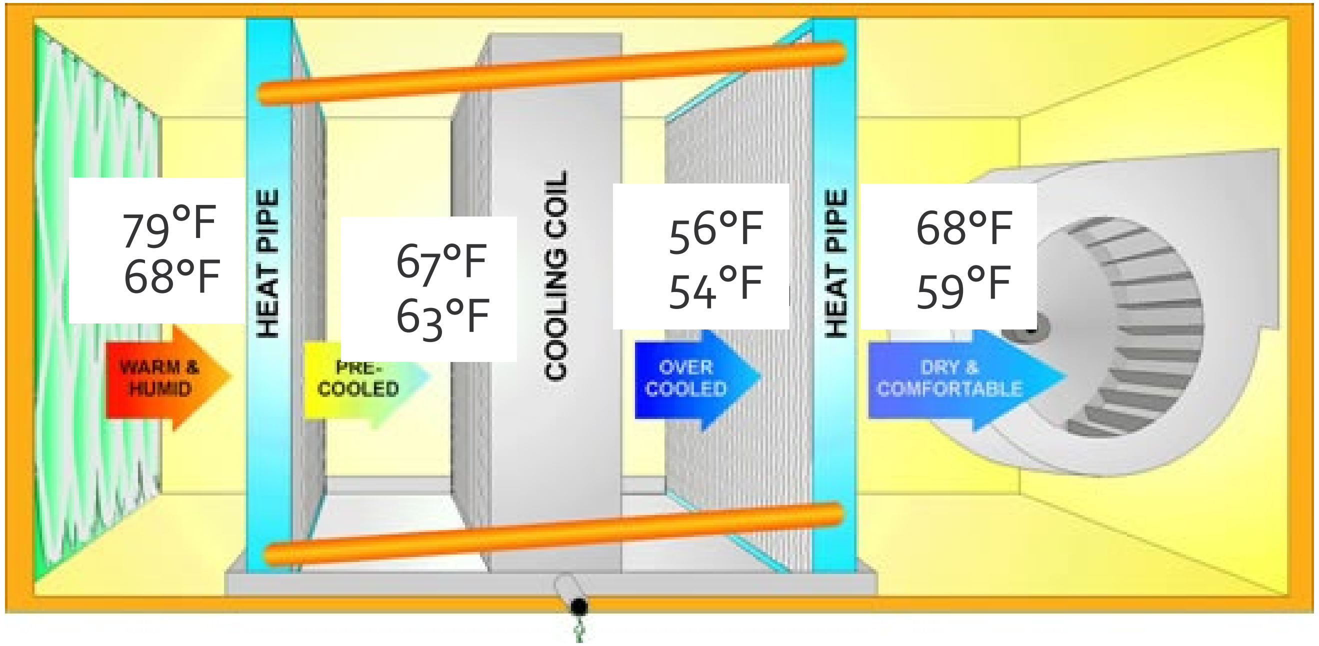


Too Cold….!

Ventilation Systems – Fully Conditioned

Step 2 - Add Heat Pipe/Hot Gas Reheat

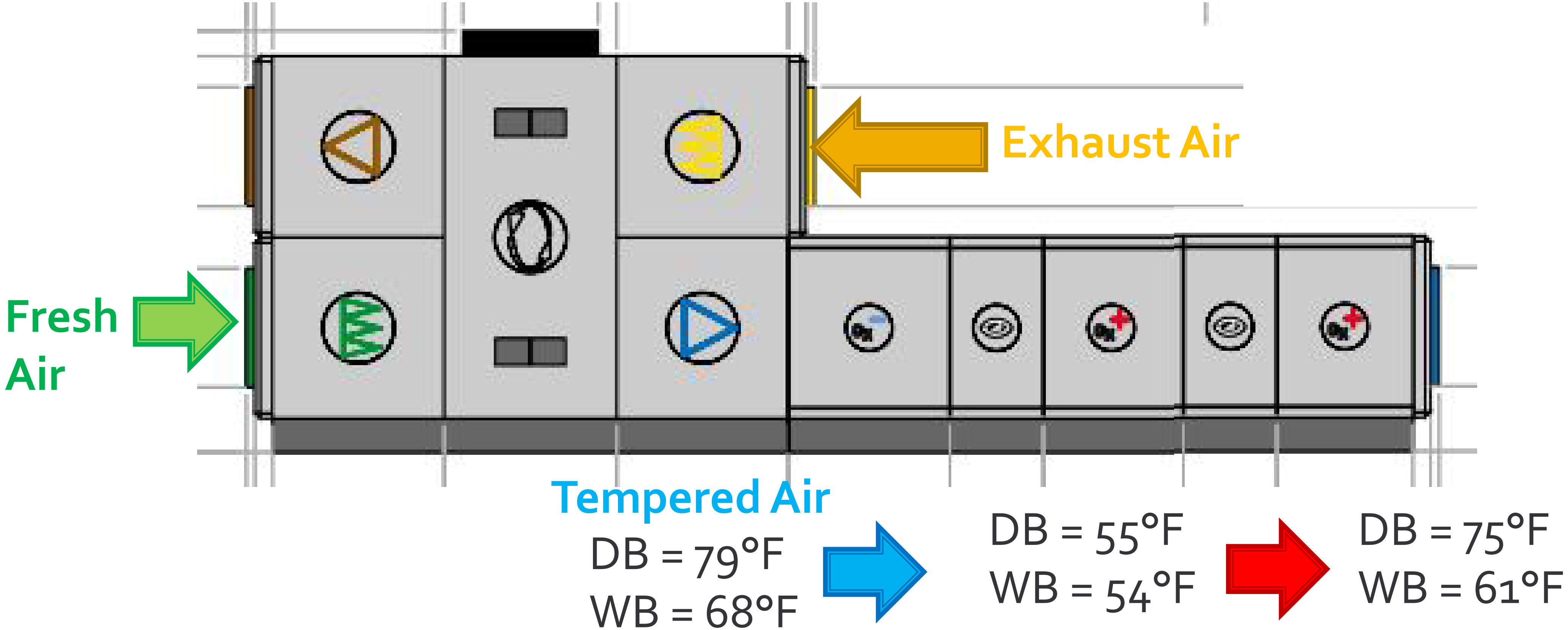
DB
WB



Still not enough….

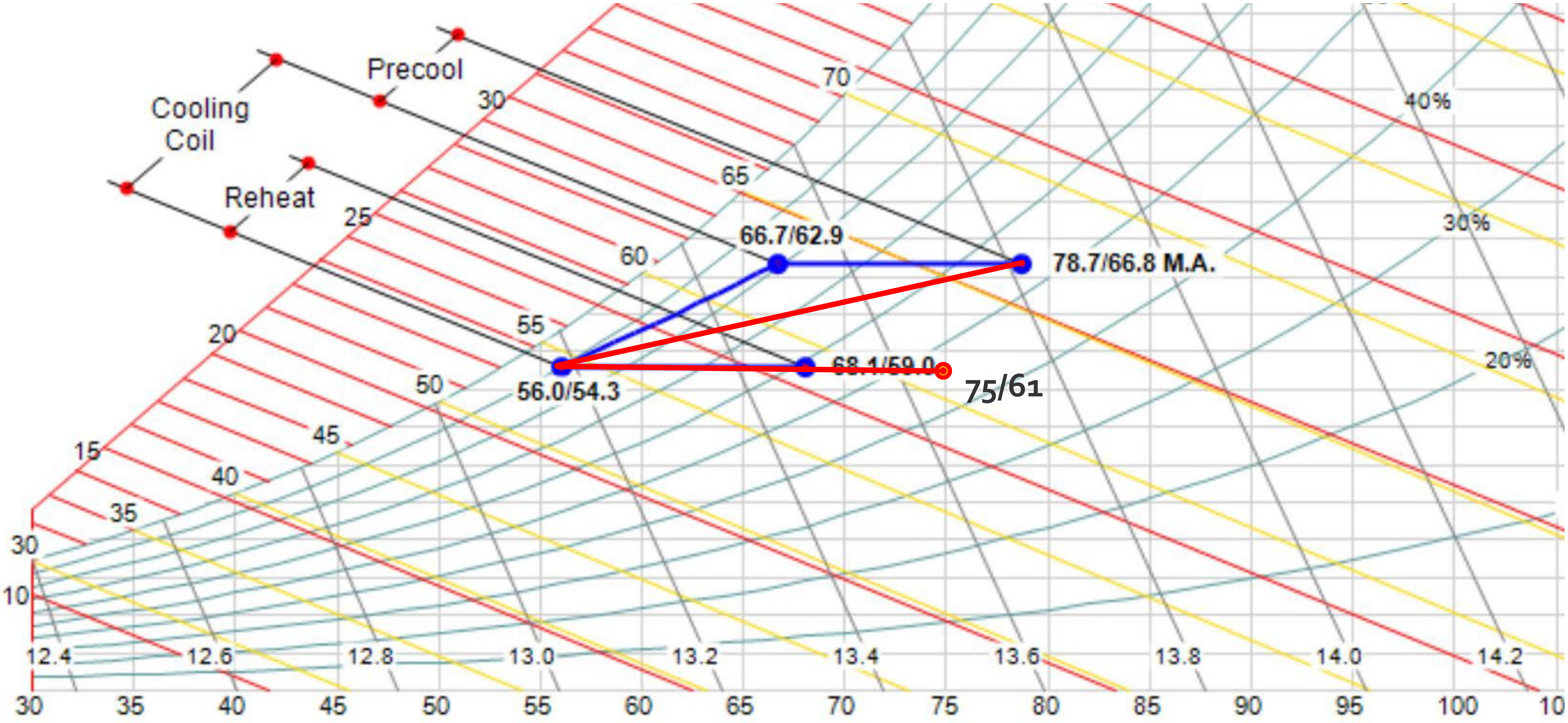
Ventilation Systems – Fully Conditioned

Step 3 - Double Heat Pump Coils



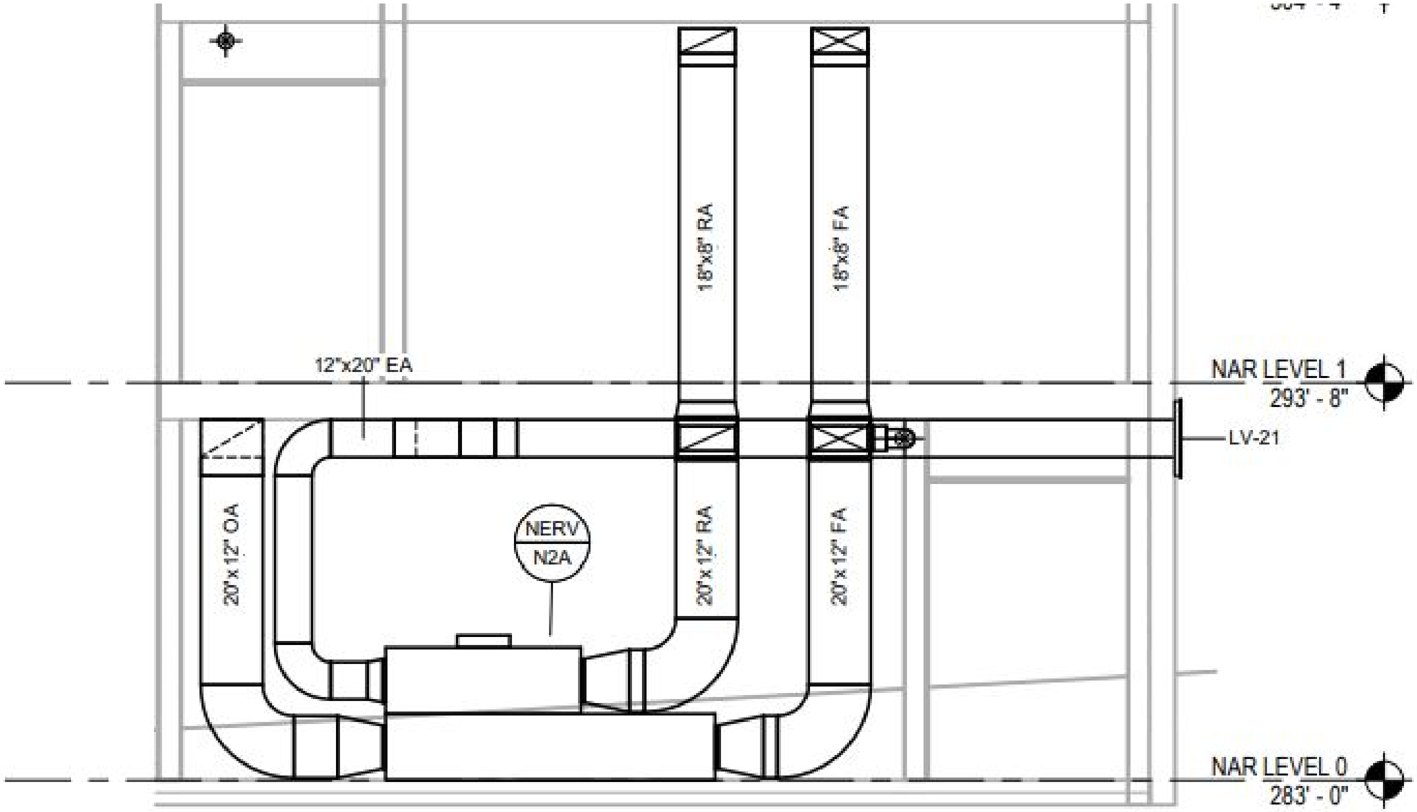
Just Right!

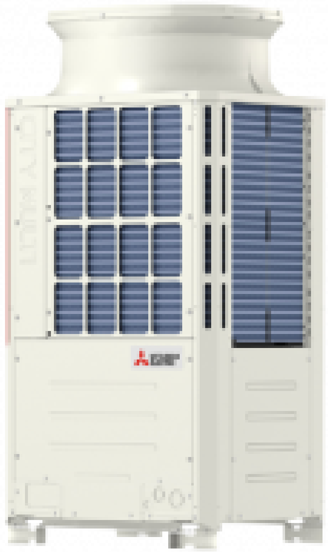
Heat Pipe vs Heat Pump



Ventilation Options

- Even Larger ERVs!





Managing Latent Loads

- 1 Bedroom Unit (intermediate floor, interior)

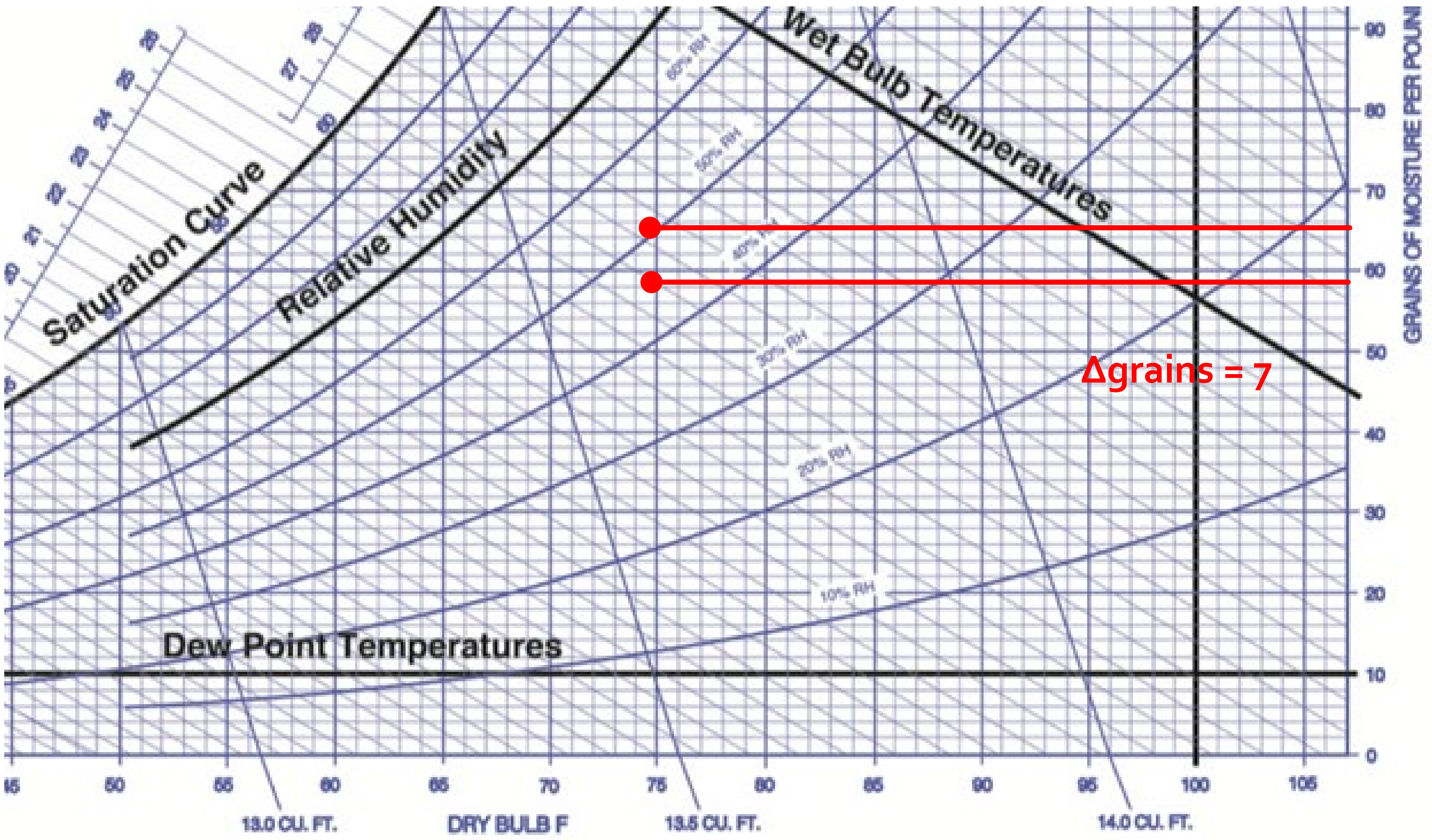
Unit Type – 1B/1B	Sensible Loss (BTUh)	Sensible Gain (BTUh)	Latent Gain (BTUh)
Ventilation (45 CFM)	2,839	930	1,098
Total	4,534	5,652	1,674
Total wo/Ventilation	**1,695**	**4,722** *	**576**

< 0.5 TONS

* Changes with orientation (even smaller!)

Ventilation Systems

- 1 Bedroom Unit
  - 45 CFM ventilation
  - Latent Load Reduction = 0.68*CFM*Δgrains =215 Btuh



Managing Latent Loads

- However - Internal Latent Gains
  - Person – 200 btuh (includes showers?)
  - Coffee maker, 1 brewing ~180 btu
  - Dishwasher, 1 cycle ~720 btu
  - Cooking, 1 burner 30 min ~900 btu
  - House plant ~20 btuh

- AVG TOTAL =

~ 12,800 Btu/day or ~ 12 pints/day

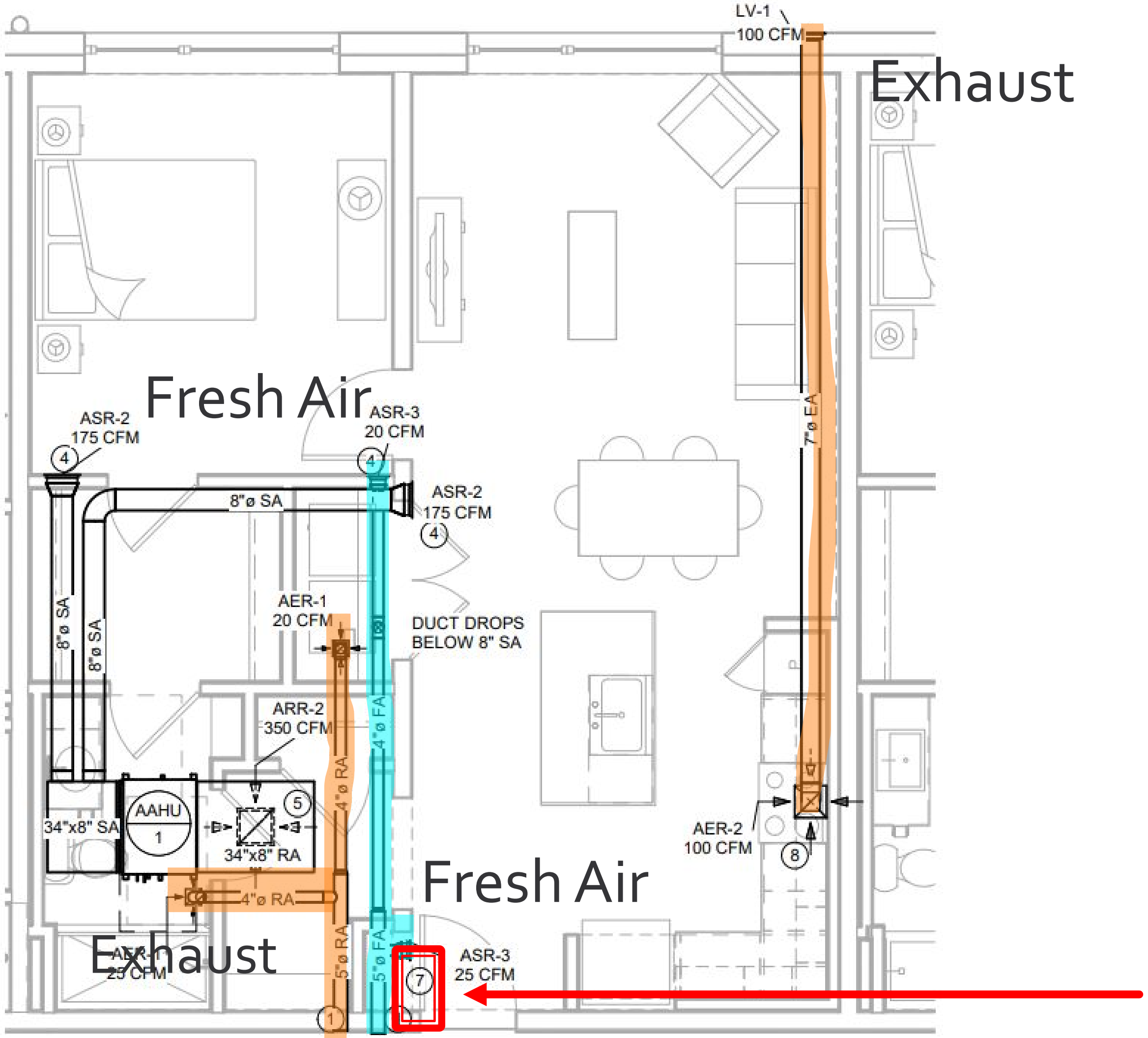
Managing Latent Loads

- Install dehumidification capability

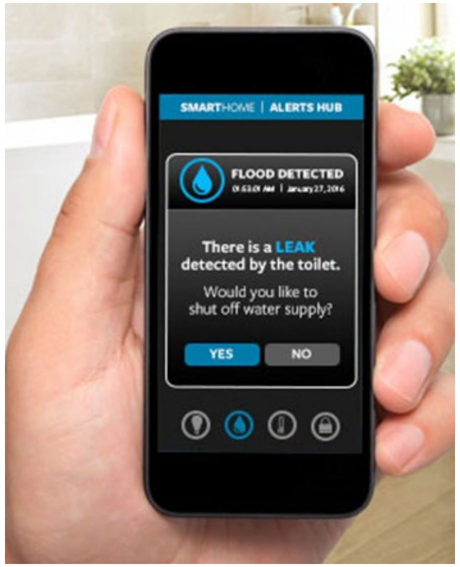
22-60
Pints/Day

Up To 33
Pints/Day

Apartment Layout



Rough In for Dehumidifier



Apartment Level Controls

Specify and Cx Temperature Ranges

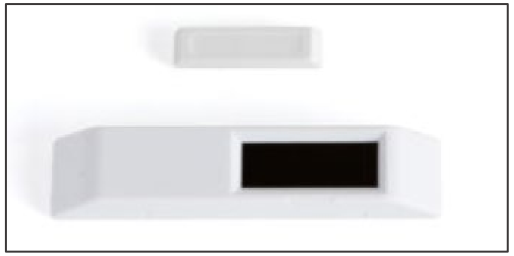
*Fan OFF When Indoor Unit Satisfied

IU Auto Deadband

Heating	Cooling
> +/- 3C	>+/- 3C

Specify Interlocks to Promote Efficiency

- When windows are open, indoor units shut-off or T setpoint is adjusted



Questions?

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