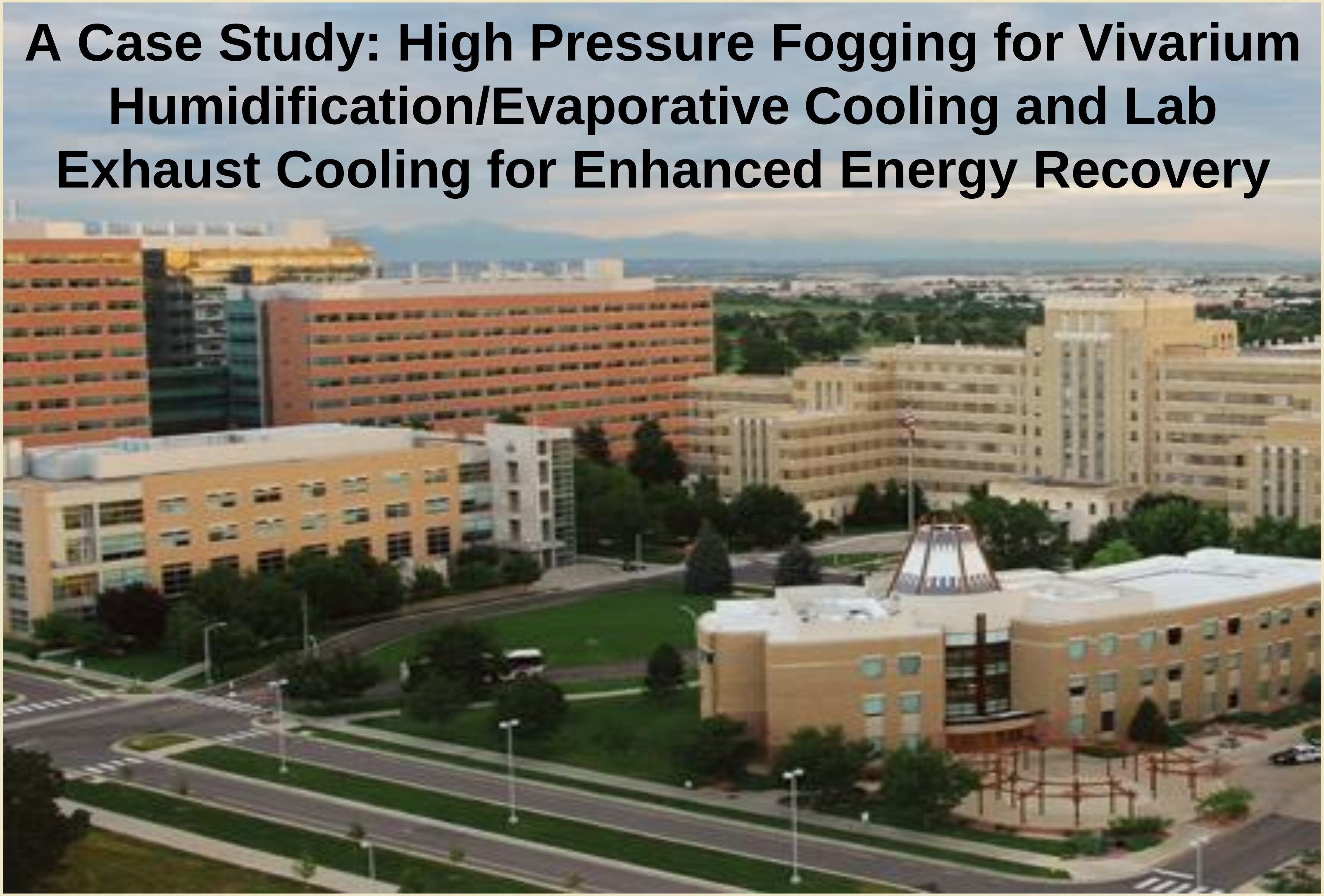
A Case Study: High Pressure Fogging for Vivarium Humidification/Evaporative Cooling and Lab Exhaust Cooling for Enhanced Energy Recovery



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A Little About Us

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A Little About Us

University of Colorado Denver | Anschutz Medical Campuses

- Doctoral High Research
- 15,000 enrolled at CU Denver and 4,270 enrolled at the CU Anschutz Medical Campus
- The CU Health Sciences Center/CU Anschutz Medical Campus established in in 1922. The CU Denver campus in 1973.
- Housing for 711 students at the Denver campus, with plans for additional 555
- 218 acres
- 37 Buildings
- 4.6 Million Building GSF combined campuses
- FM – 245 employees
- Central Steam and Chilled water distribution loop for the university and two hospitals, over 7.7 Million GSF

Humidification and Evaporative Cooling

MeeFog Humidification:
What can it do for you?

Save Energy

1 Hp motor delivers 600 lbs/hr.

Save Money

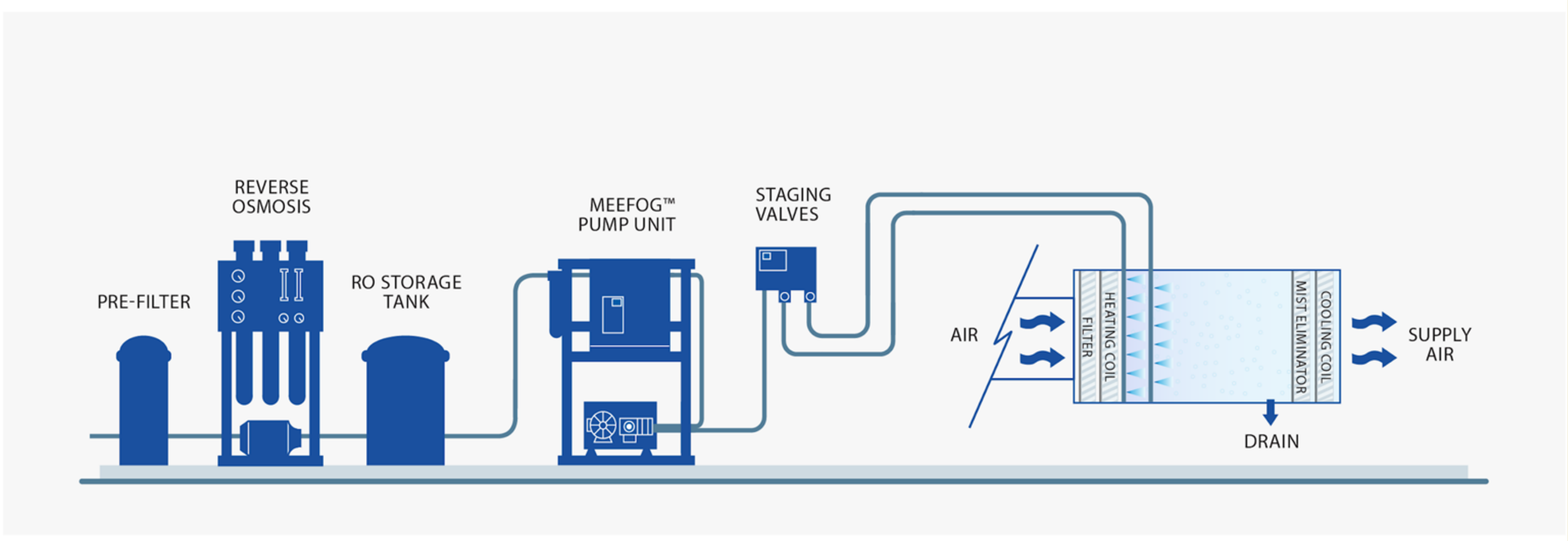
Uses existing heat in the air to evaporate water droplets. This saves energy & $$$.

LEED the Way

Reduction in energy use can help your building earn LEED points.

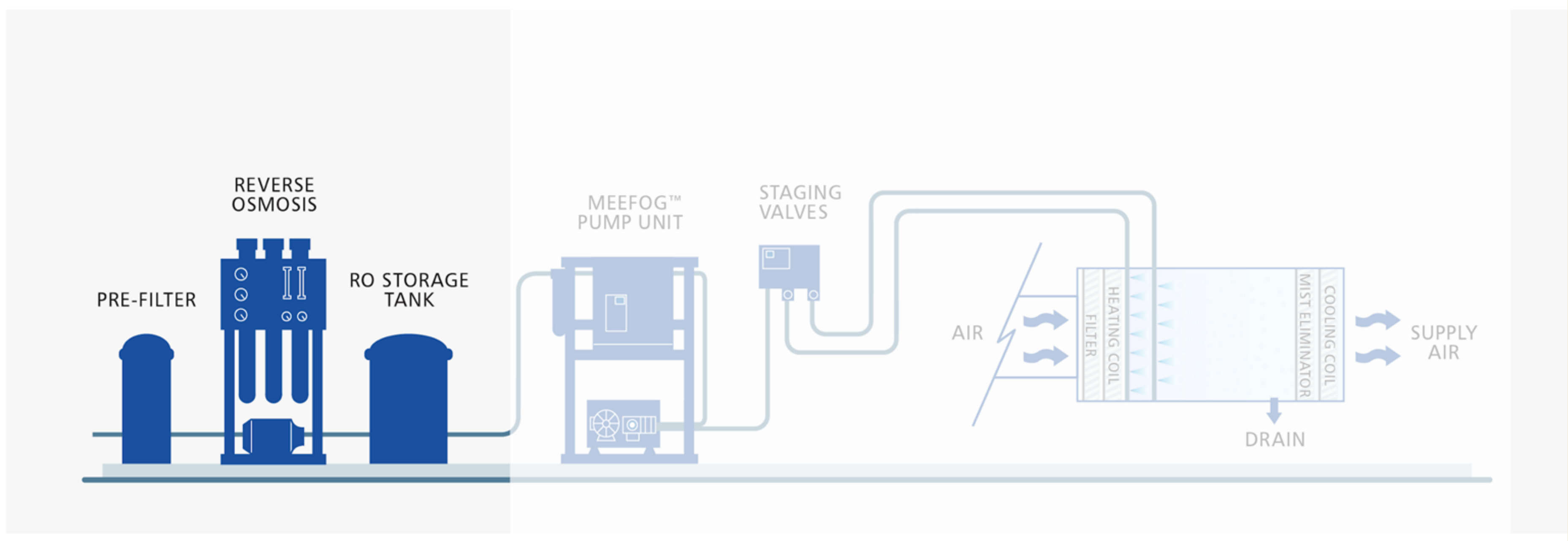
Vivarium Humidification and Evaporative Cooling

How It Works: High Pressure Fogging System - HVAC Application



Vivarium Humidification and Evaporative Cooling

How It Works: Reverse Osmosis



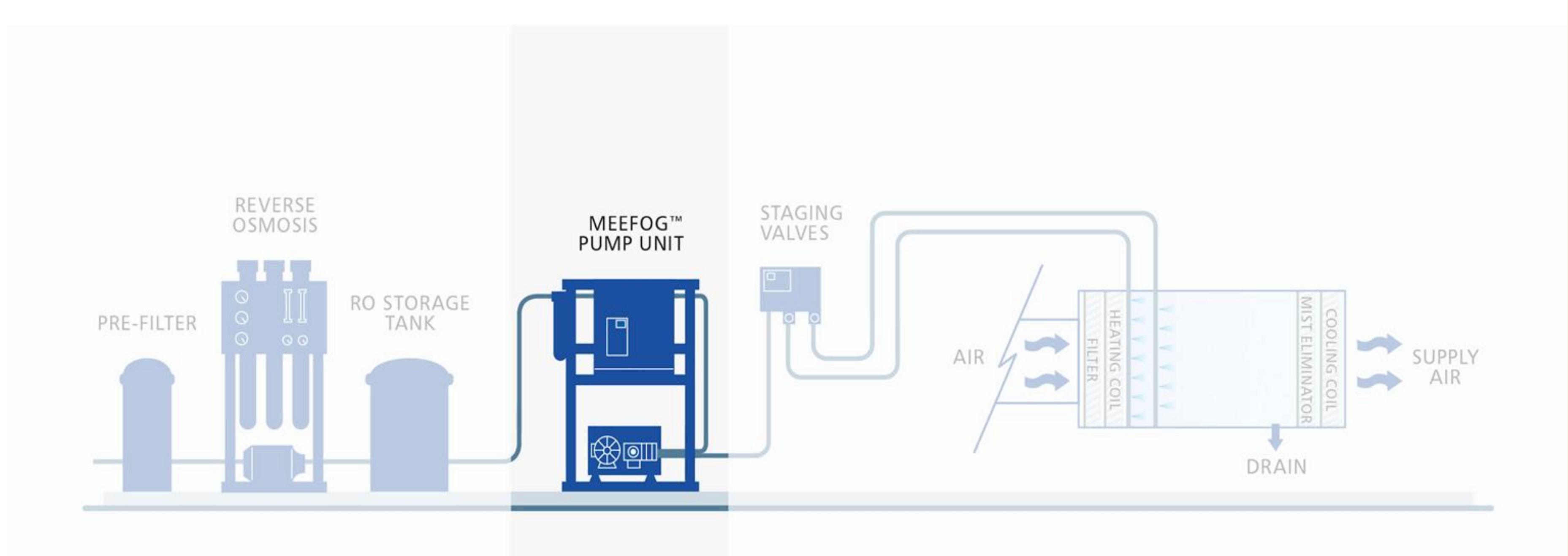
Vivarium Humidification and Evaporative Cooling

Reverse Osmosis
Water Purification

- Removes mineral content including Calcium, Magnesium, and TDS
- Removes microbes
- Maintains water quality using UV sterilizers

Vivarium Humidification and Evaporative Cooling

How It Works: Fog Pump



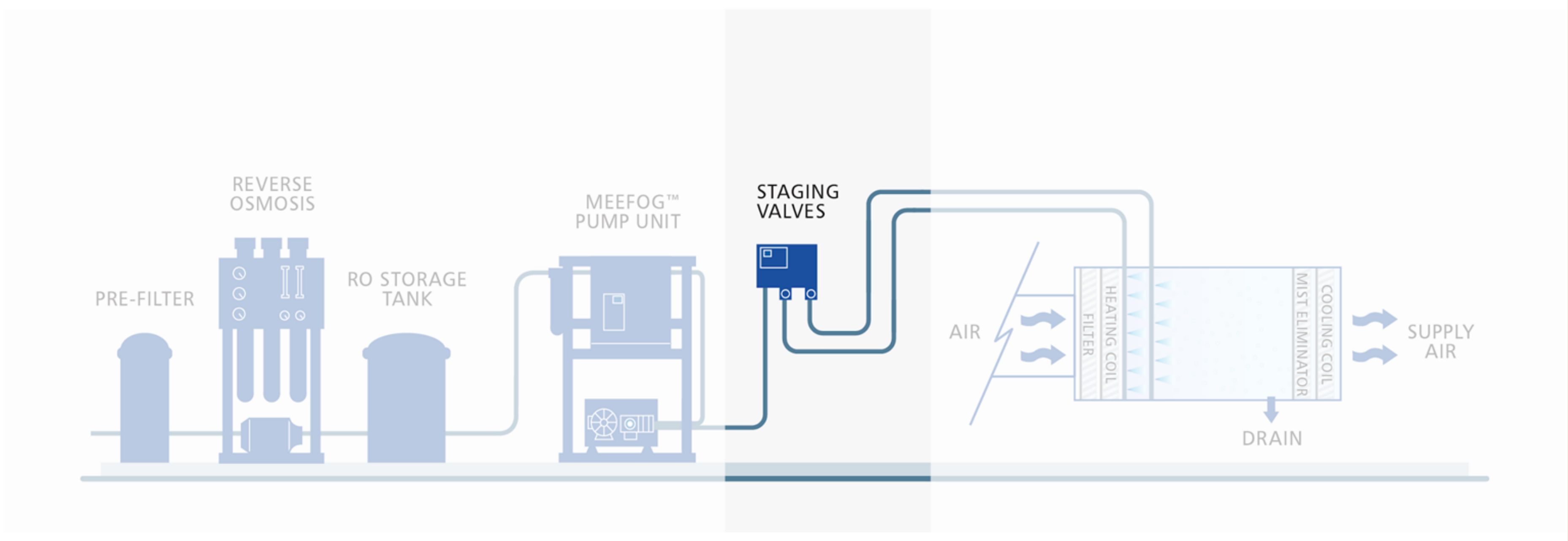
Vivarium Humidification and Evaporative Cooling

Fog Pump

- Maintains pressure at 1000 psi
- Can serve multiple AHUs

Vivarium Humidification and Evaporative Cooling

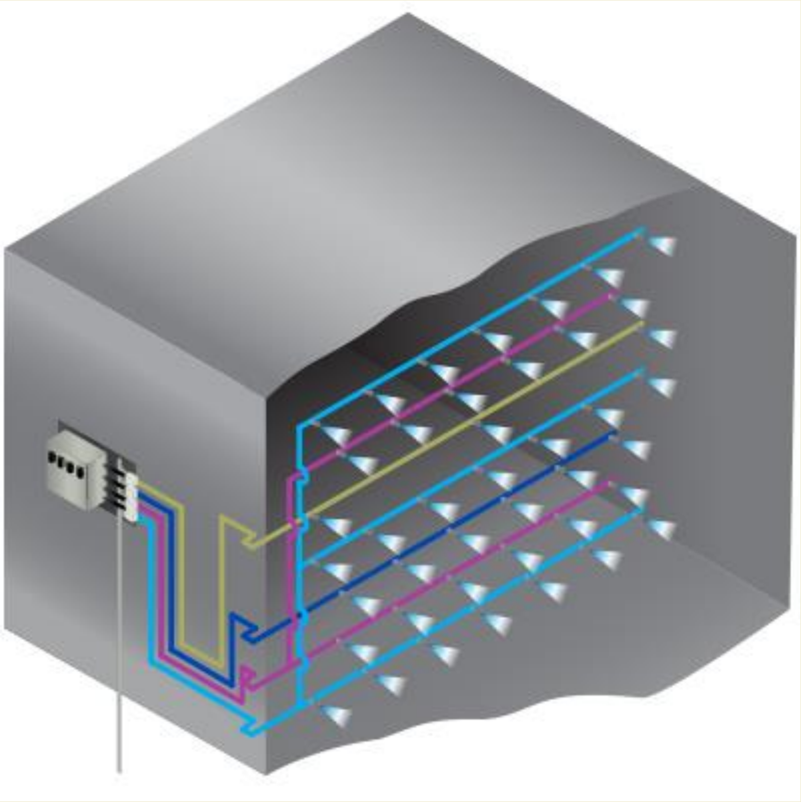
How It Works: Staging Valves



Vivarium Humidification and Evaporative Cooling

Staging Valves

- Valves modulate the output of the Fog system via a staging schedule
- Each valve controls a different number of fog nozzles
- PLC in valve panel receives variable humidification demand signal from BMS



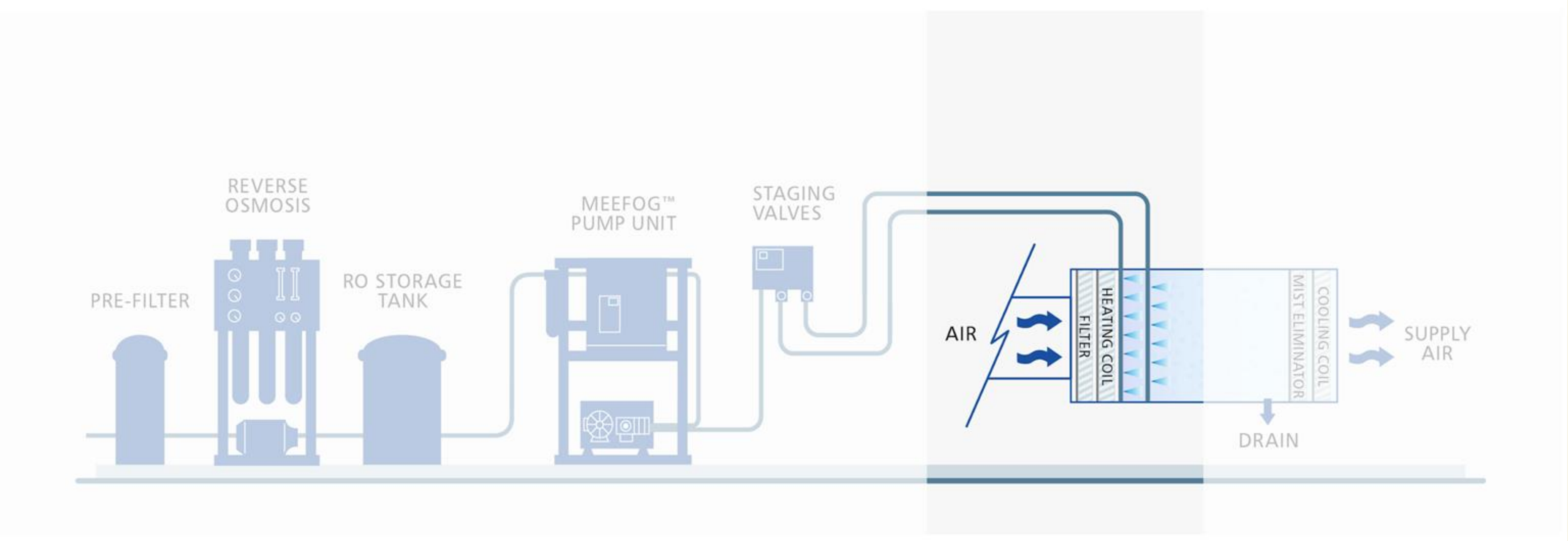
Vivarium Humidification and Evaporative Cooling

STAGING SCHEDULE EXAMPLE

STAGE	SOLEINOID				NOZZLES	OUTPUT	NET OUTPUT/ EVAP. EFFICIENCY	CAPACITY
	VALVE 1	VALVE 2	VALVE 3	VALVE 4	KEY	#/hr	75%	%
1	ON				3	48	36	7.1
2		ON			6	96	72	14.3
3	ON	ON			9	144	108	21.4
4			ON		12	192	144	28.6
5	ON		ON		15	240	180	35.7
6		ON	ON		18	288	216	42.9
7				ON	21	336	252	50.0
8	ON			ON	24	384	288	57.1
9		ON		ON	27	432	324	64.3
10	ON	ON		ON	30	480	360	71.4
11			ON	ON	33	528	396	78.6
12	ON		ON	ON	36	576	432	85.7
13		ON	ON	ON	39	624	468	92.9
14	ON	ON	ON	ON	42	672	504	100.0

Vivarium Humidification and Evaporative Cooling

How It Works: Nozzle Manifolds

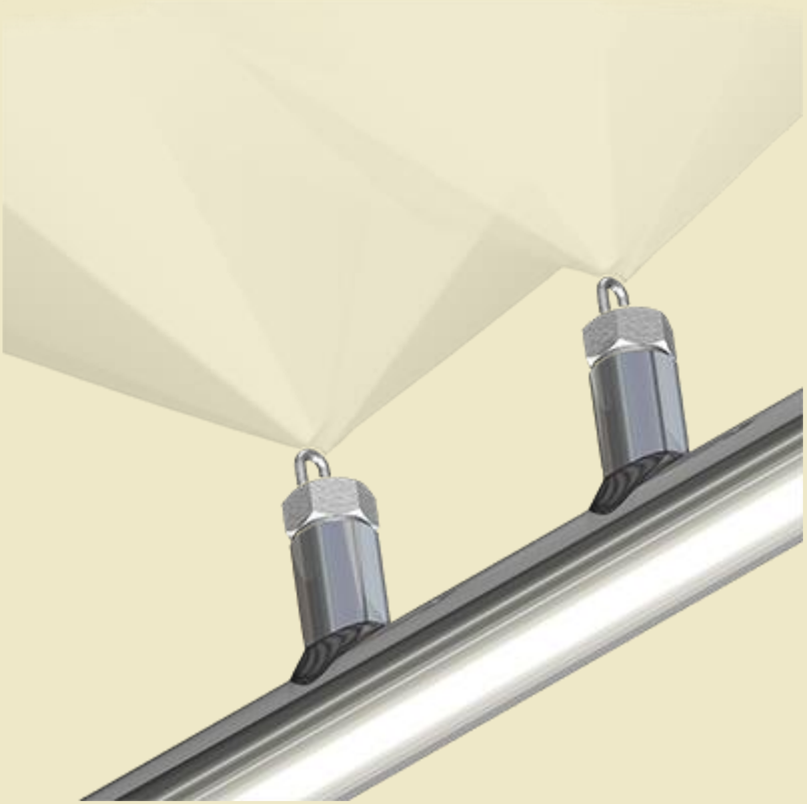


Vivarium Humidification and Evaporative Cooling

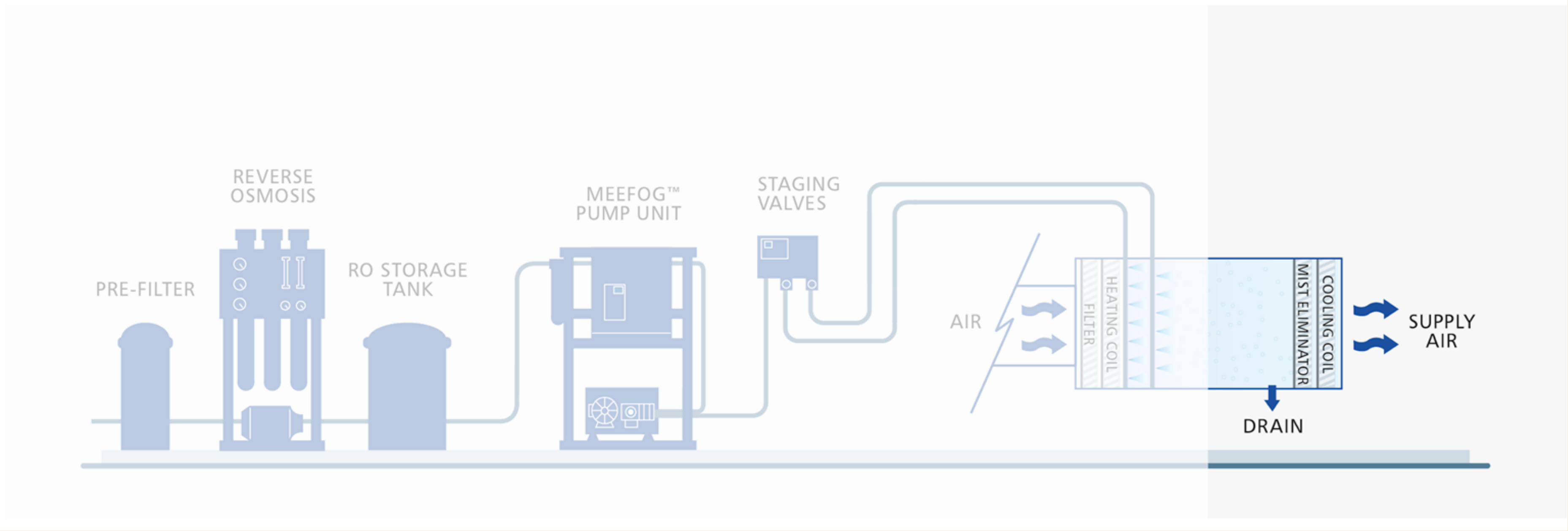
Nozzle Manifolds

- Stainless steel tubes with nozzles evenly spaced for ideal coverage

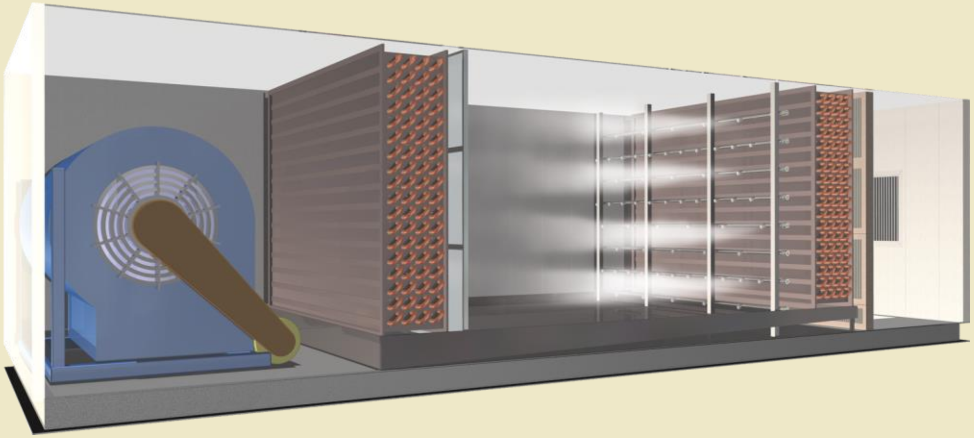
- Creates fog that is an average of 17 micron in diameter. Human hair is around 100 micron in diameter.



How It Works: Mist Eliminator



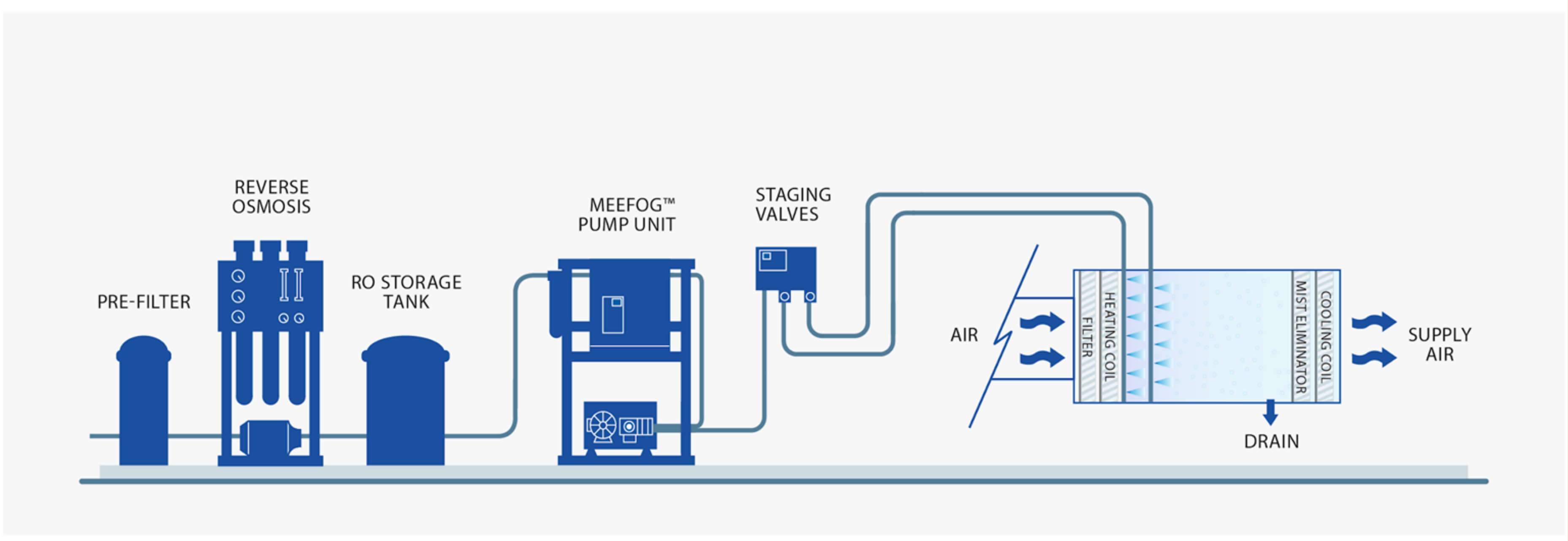
Vivarium Humidification and Evaporative Cooling



Mist Eliminator

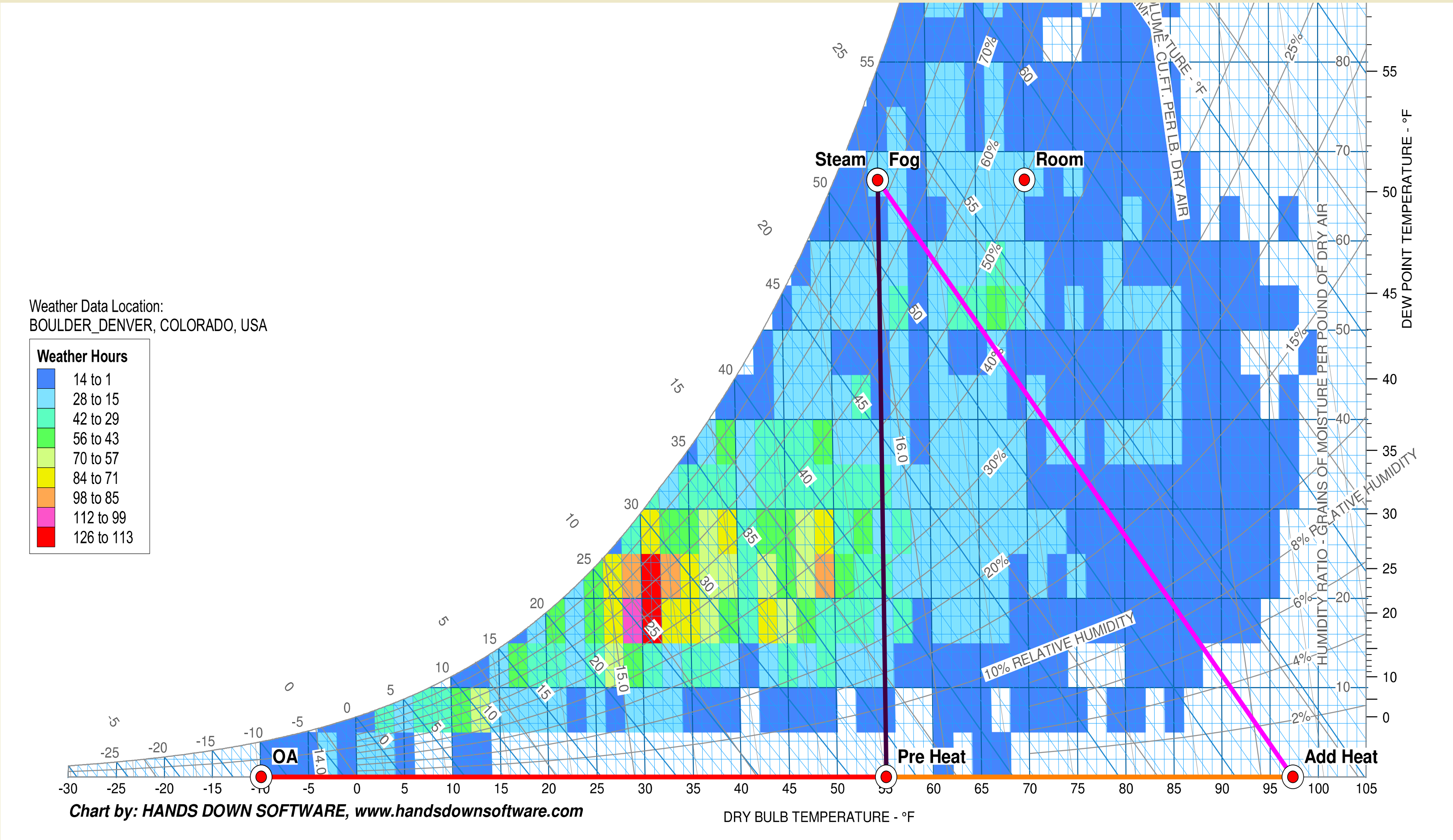
- Removes droplets > 5 microns
- Absorption distance 3-6 feet
- Filter media can be removed for cleaning or replacement
- Media acts as secondary means of evaporation

HVAC - High Pressure Fogging System



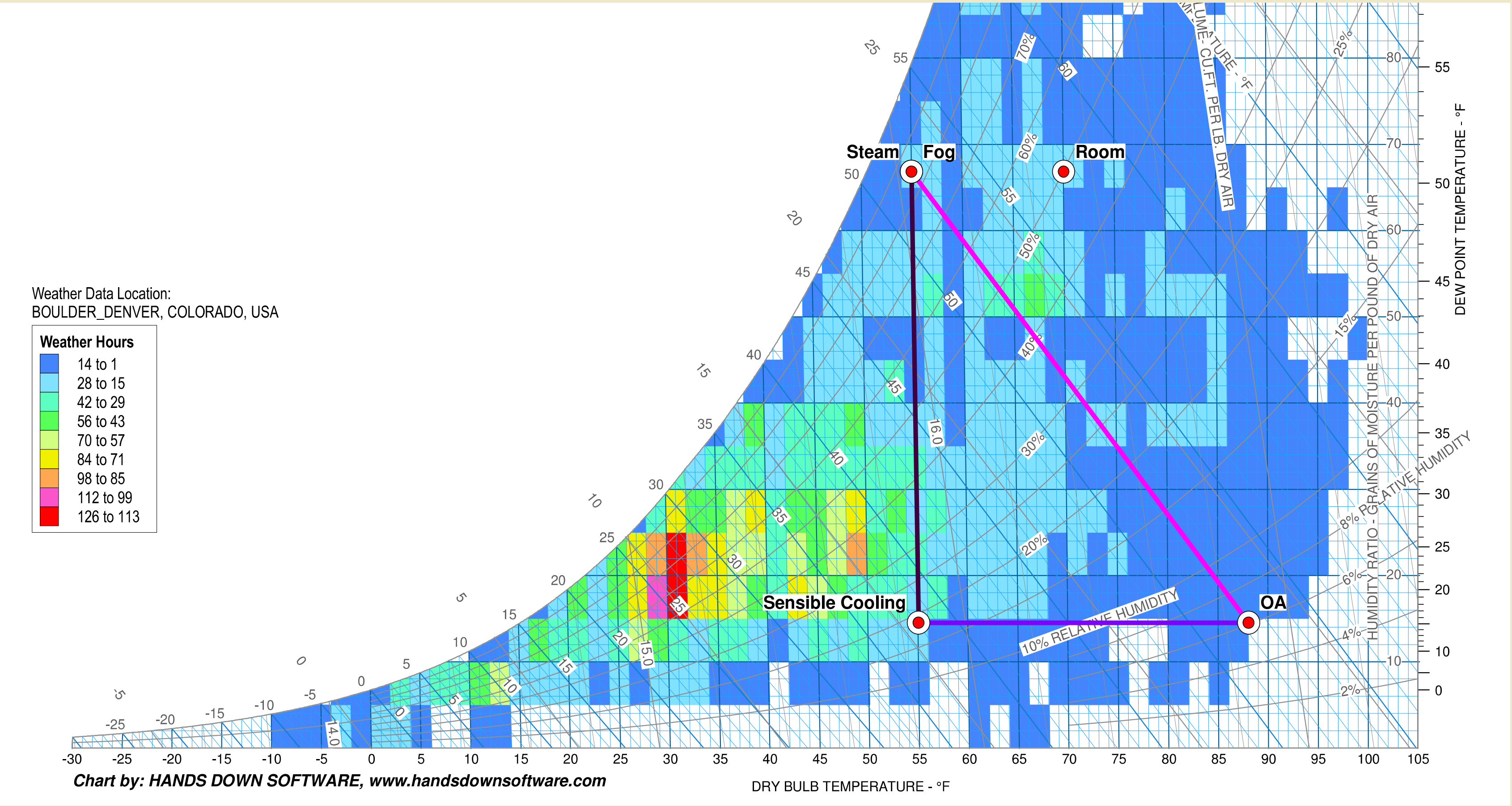
Vivarium Humidification and Evaporative Cooling

Winter Psychart – 100% OA

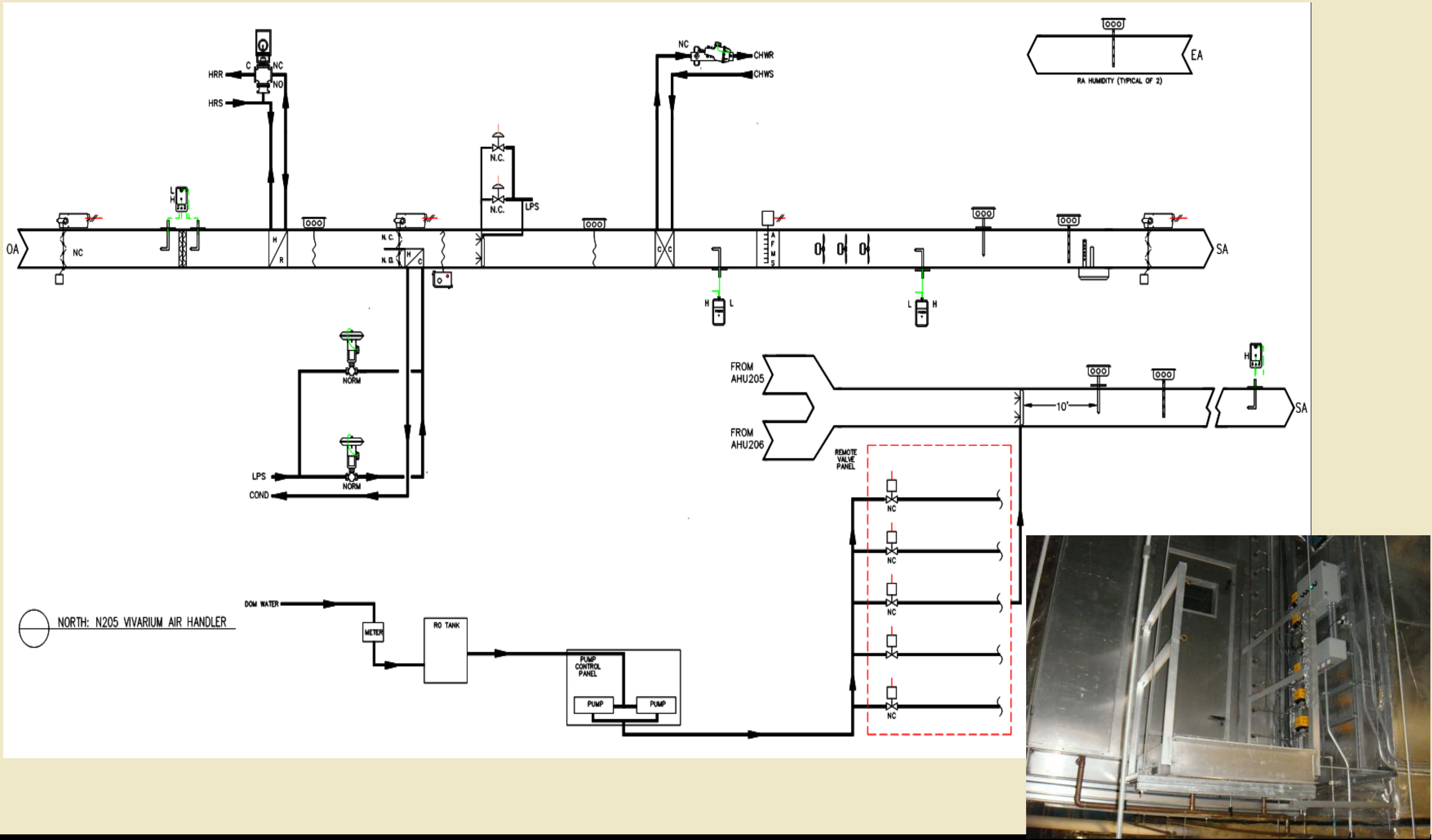


Vivarium Humidification and Evaporative Cooling

Summer Psychart – 100% OA



Vivarium Humidification and Evaporative Cooling



Vivarium Humidification and Evaporative Cooling

Sequence:
Each Vivarium air handling units shall have their supply temperature and humidity setpoints reset to satisfy the common vivarium air handling unit at setpoint. Each air handling unit utilizes its own master loop to maintain each sections setpoint. The high-pressure fogging accomplishes cooling during the process of humidification and saves energy by limiting the uses of the clean steam generator and mechanical cooling.

When the outside air temperature is above 40° F, the high-pressure fogger shall act as the primary source of humidification and shall index solenoid valves. The air handling unit previously installed steam humidifier coils shall act as supplemental humidification when the high-pressure fogger is unavailable to run or cannot achieve set point.

When the outside air temperature is below 40 deg F, the air handling unit steam humidifier coils shall act as the primary source of humidification. In this mode of operation, the high-pressure fogger shall act as supplemental humidification. when either air handling unit steam humidifier coil cannot achieve its set point. The temperature rise across the steam humidifier shall be the first stage of heating.

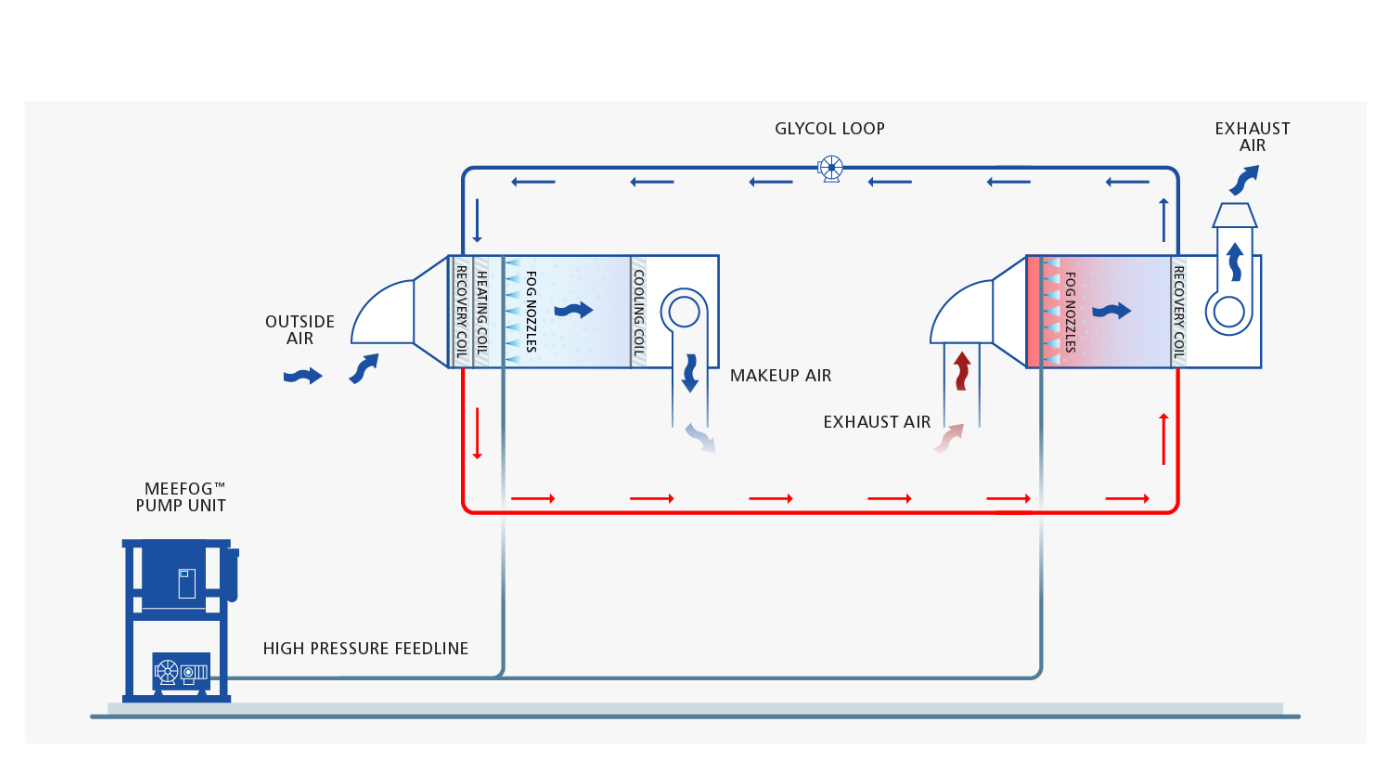
Vivarium Humidification and Evaporative Cooling

Supply Annual Energy Savings – One Vivarium AHU

2018	Ton-hrs	Gallons	CHW Cost Avoided
January	38,913	64,531	$8,755
February	39,107	64,320	$8,799
March	47,568	70,106	$10,703
April	52,995	81,355	$11,924
May	34,646	52,958	$7,795
June	35,674	55,690	$8,027
July	7,053	10,297	$1,587
August	9,519	13,297	$2,142
September	32,429	48,244	$7,297
October	42,532	65,393	$9,570
November	10,360	16,808	$2,331
December	35,060	68,807	$7,889
			$83,281

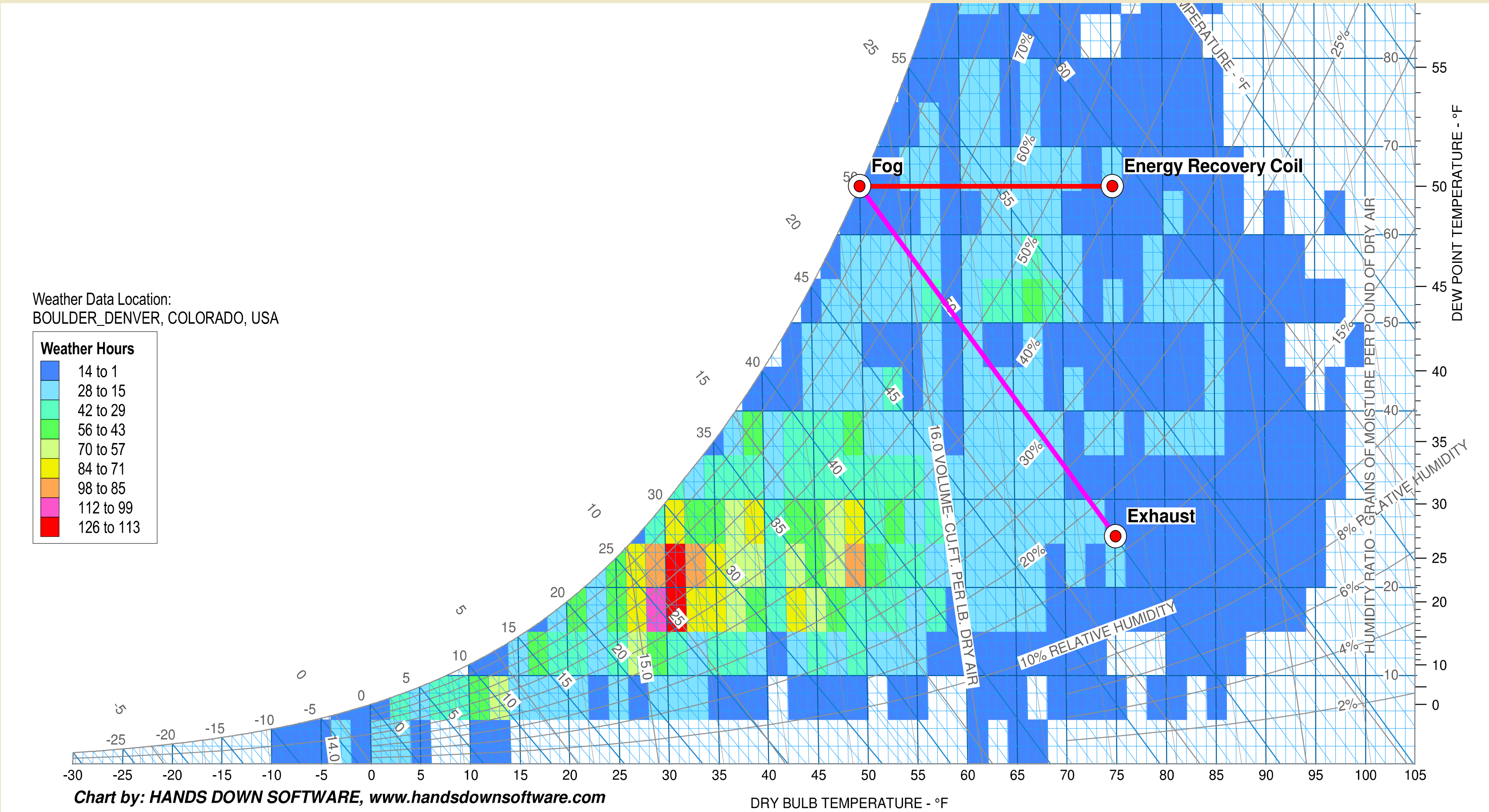
Exhaust Evaporative Cooling

Energy Recovery Coil with Summer Fogging

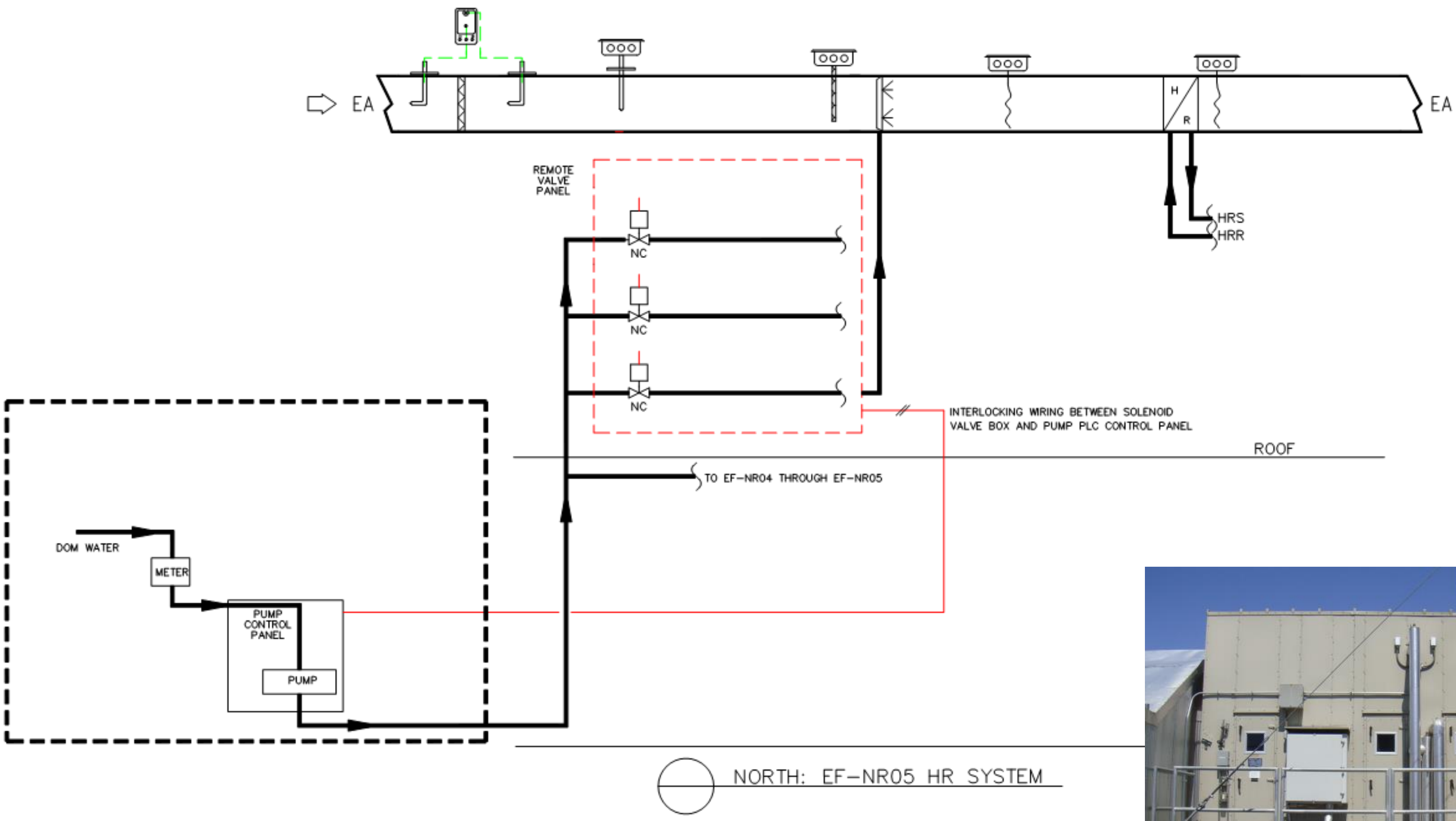


Exhaust Evaporative Cooling

Exhaust Summer Psychart



Exhaust Evaporative Cooling



Exhaust Evaporative Cooling

Sequence:
The high-pressure fogger system will operate when the heat recovery pumps are on when the outside air temperature is above 75° F.

The air intake temperature and humidity sensors are used to calculate the theoretical wet bulb low limit possible for the high-pressure fogger discharge air setpoint. The setpoint will be reset between based upon maximum heat recovery valve position of running AHU heat recovery sections.

The solenoid valves in the high-pressure fogger section will stage total capacity and will be staged incrementally based on delta T between high pressure discharge air temperature setpoint. The unit will stage up and down to prevent excessive usage of water in low demand conditions.

The BTU effectiveness for the high-pressure fogger will be calculated based on the difference between temperatures and the exhaust air volumes.

Exhaust Evaporative Cooling

Exhaust Annual Energy Savings – Three HRUs

BIN hours	min	max	avg
7	95	99	97
71	90	94	92
174	85	89	87
291	80	84	82
384	75	79	77
494	70	74	72
618	65	69	67
794	60	64	62
776	55	59	57
739	50	54	52
729	45	49	47
752	40	44	42
724	35	39	37
704	30	34	32
555	25	29	27
394	20	24	22
243	15	19	17
137	10	14	12
84	5	9	7
54	0	4	2
22	-5	-1	-3
13	-10	-6	-8
5	-15	-11	-13
3	-20	-16	-18
1	-25	-21	-23
8768			

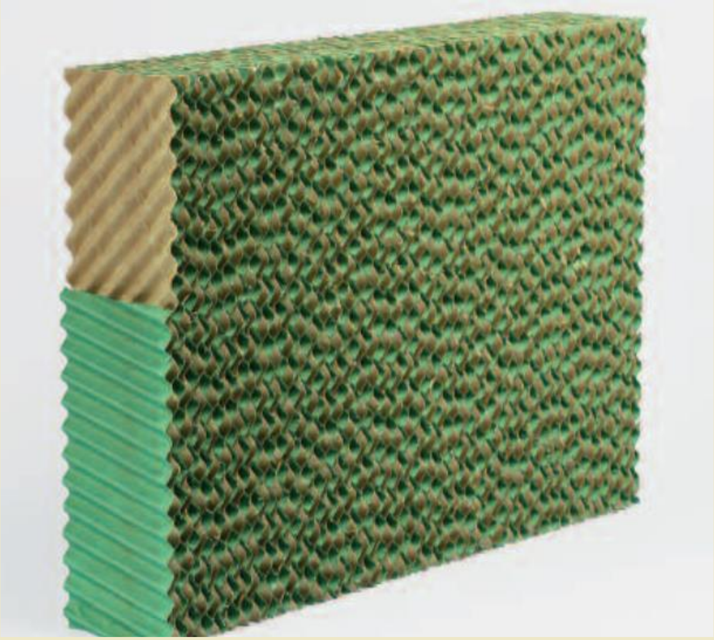
R1 North HRU Fog Cost Savings Analysis

Annual Hours above enable setpoint	1174
Average Delta T across Fog HRU	13
Average CFM of 1 HRU	34454
Annual Total Ton-Hrs for 3 HRU	119,715
FY2020 Unit Cost for Ton-hr	0.241
Annual Cost For Ton-Hrs	$28,851
Estimated Gallons for 3 HRU	239,430
Annual Cost for 1,000 Gallons	5.87
Annual Cost for Water	$1,405
Net Annual Savings with Fog HRU	$27,446

Lesson Learned

High-pressure fogging versus traditional evaporative cooling

- No media to replace and no pumps in exhaust stream to replace
- No recirculating water sump that creates a favorable environment for bacteria growth



Lesson Learned

High-pressure fogging maintenance

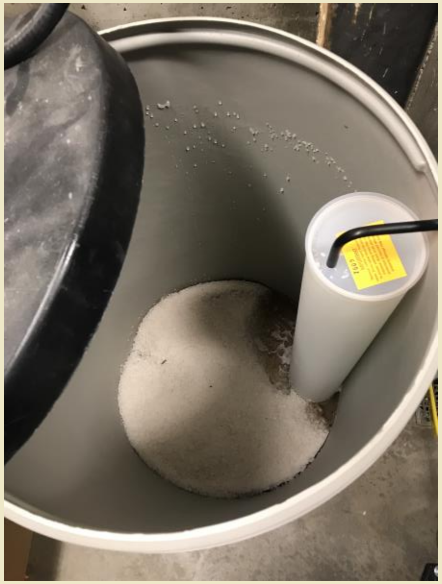
- Isolation damper upstream of each ERU to be able to service each section one at a time
- Add sensors before and after each section to measure performance
- Maintenance program for air filter replacement and to service anything inside of ERU
- Using a wider fin spacing coil may not require upstream filtration

Lesson Learned

Water Quality

- RO water is more expensive than softened water, so who cares about some white dusting in the ERU?
- Well, unfortunately, the water softeners are not being maintained at many campuses

Campus #1



Campus #2

Campus #3

Lesson Learned

Water Quality

- So, then the calcium and magnesium are not being removed from the water, thus scaling up the coils and fog nozzles. This reduces the energy transfer, increases air pressure drop and creates additional maintenance.
- Even with campuses that have maintained the water softener, getting into the exhaust units are hazardous and difficult to schedule shutdowns.
- Thus, the best solution is to provide RO water to the fogging system and eliminating the need to enter the exhaust units for maintenance due to scaling.

Lesson Learned

ERU construction

- Some metal ERU manufactures sometimes don't do the best job of making the ERU water tight or understand the need for a wash down type exhaust unit.
- Metal can rust and can have issues with dissimilar metals, paint adhesion, and creepage.

Lesson Learned

ERU construction

- Corrosion coatings on metal units are just that, they are coatings.

FRP Control

Galvanized Control

Epoxy-Coated Control

- Constructing the entire ERU out of FRP eliminates off the the aforementioned issues as the corrosion coating is inherent to the material and the system is water tight. FRP also provides a weight savings over a steel product.

Questions?

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