

Renovation of Vivarium Air Flow Controls on Campus for Energy Efficiency and Reduced Work Orders



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Learning Objectives

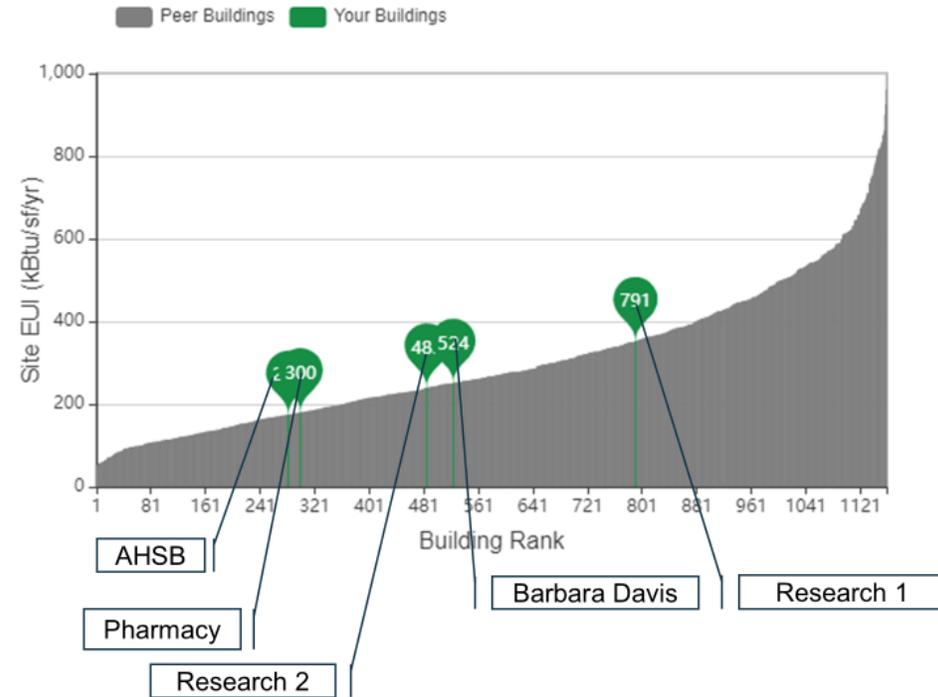
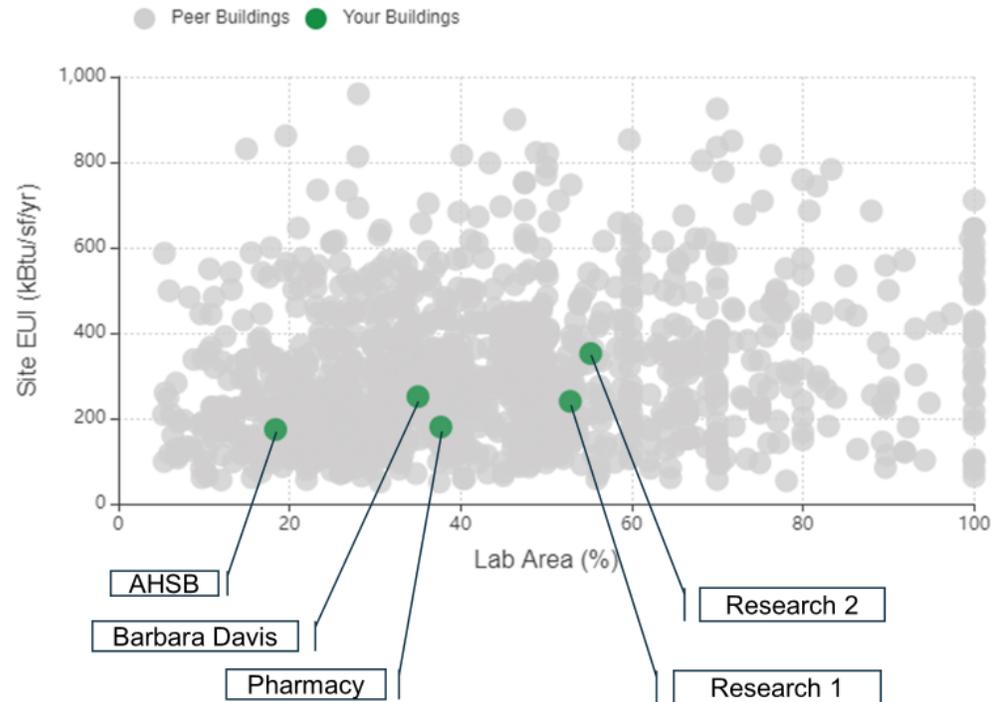
- Describe the facility staff's current maintenance struggles and component failures with the existing air flow control system;
- Understanding the challenges of retrofitting the controls in an active vivarium and state funding;
- Identify lessons learned from the design information and actual installation; and
- Explain how the selected air flow control system can help eliminate the existing maintenance issues, increase energy savings, and reduce the field startup time of the limited phasing schedule.

About Us – CU Anschutz Medical Campus

- The CU Health Science Center was established in 1922
- In 2000, construction began on what is now the CU Anschutz Medical Campus on the old Fitzsimmons Army Medical Garrison
- The campus covers over 218 acres and 4.3 million GSF of buildings
- School of Medicine, College of Nursing, School of Dental Medicine, School of Public Health, School of Pharmacy, and Graduate School
- Doctoral High Research
- 4,500 enrolled at the campus
- Facilities Management consist of 276 employees
- The Central Steam and Chilled Water distribution loop serves both the University and two hospitals, over 9 million GSF

I2SL Laboratory Benchmarking Tool

How our lab buildings compare nationally



Research 1 History – Air Valve Replacement

- 2002-2004 construction period during state budget crunch
- Budget cuts during construction eliminated many energy recovery systems
- Facilities has been trying to improve and make up every since construction.
- Approaching 20 years on air flow systems and controls
- Upgrades needed, but wanted to address some operational changes at the same time
- Part of an overall building energy improvement strategy

Current Building Issues

- Facility work orders average two per month directly related to the existing mechanical venturi lab airflow control system
- Work orders are mainly driven by the user/occupant complaints and/or BMS alarms on temperature and air flow balance

Current Building Issues

- Linkages and cones break and failing in the air stream
- When this occurs, we have to shut down the room and pull the valve out of the duct work to make the repairs.



Current Building Issues

- Clogged pressure sensors leading to loss of air flow measurement



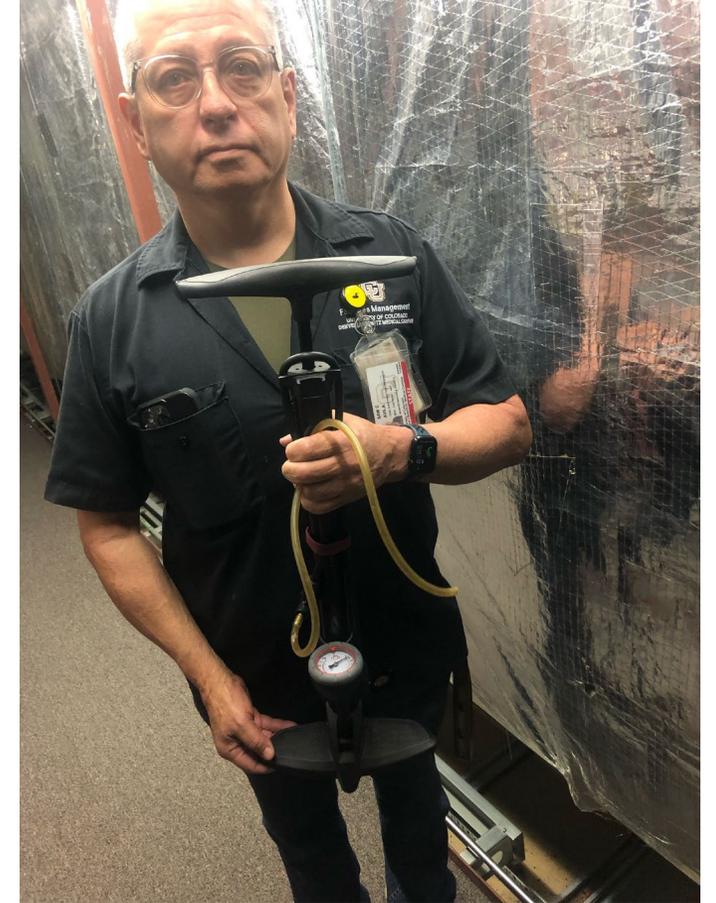
Current Building Issues

- Blowing out the pressure sensor blockage with an in-house designed tool



Current Building Issues

- Blowing out the DP blockage in action



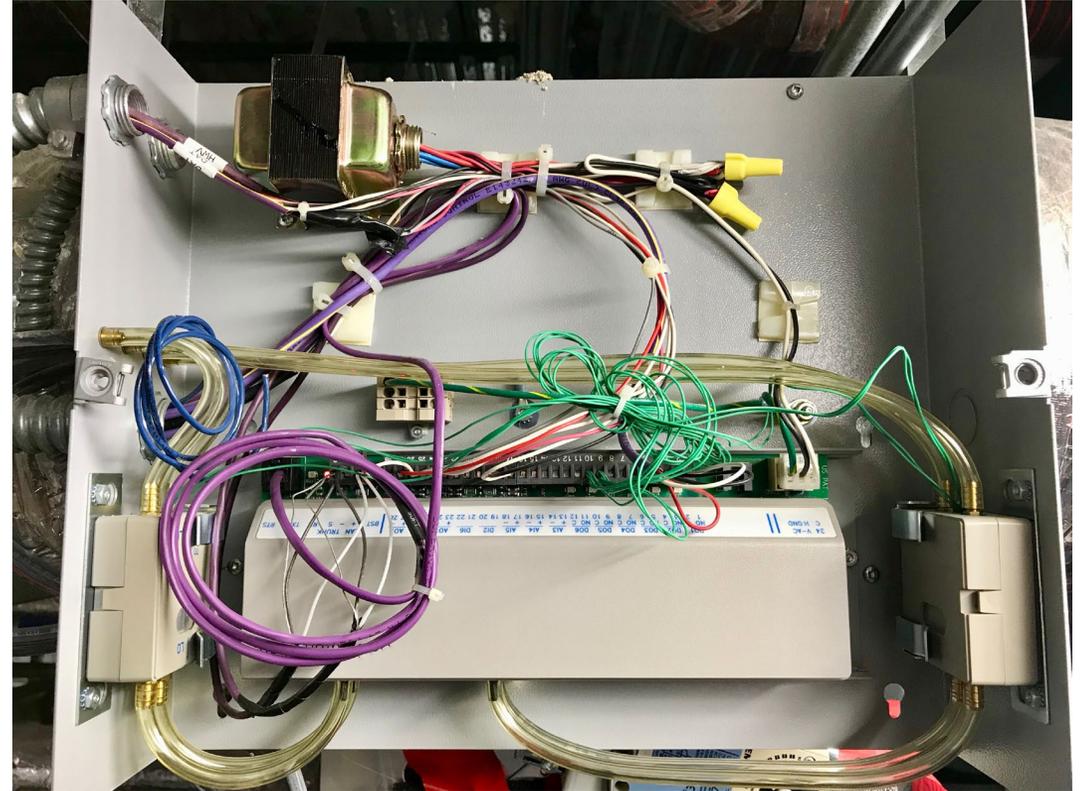
Current Building Issues

- When the bike pump doesn't work.....
- Drill into the duct and use a wire brush to scrub the airflow sensor
- If that doesn't work, we have to shut down the room and pull the valve out from the ductwork



Current Building Issues

- End of product life with job specific controllers that have the DP sensor built into the controller
- Note: We lose airflow measurement temporarily every 4 hours when the DP runs the “auto zero” calibration cycle



Understanding the Critical Environment

Use technology to create a product for Critical Environment Airflow Control that has:

- ✓ Low pressure drop design
- ✓ Accurate linear control
- ✓ Fast speed of response
- ✓ Precise true airflow measurement without straight run
- ✓ Energy savings through less fan hp
- ✓ Low acoustics (sound pressure levels)
- ✓ Great owner flexibility / free software to access the system
- ✓ Simplified application / installation with no position sensitivity
- ✓ Low to no maintenance
- ✓ Pre-Programmed and easy to start up

Air Valve Technologies



VAV Box



Mechanical Cone Venturi

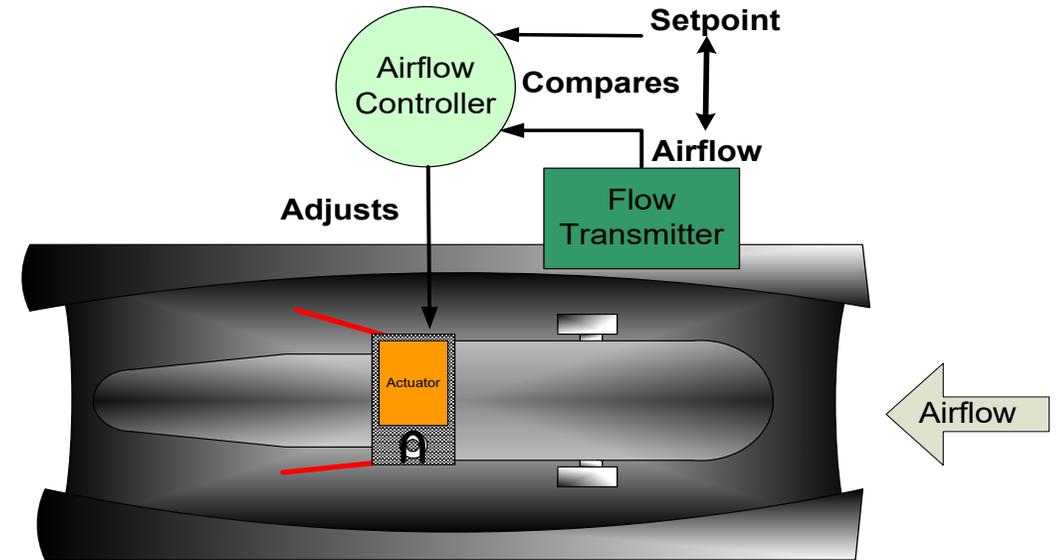
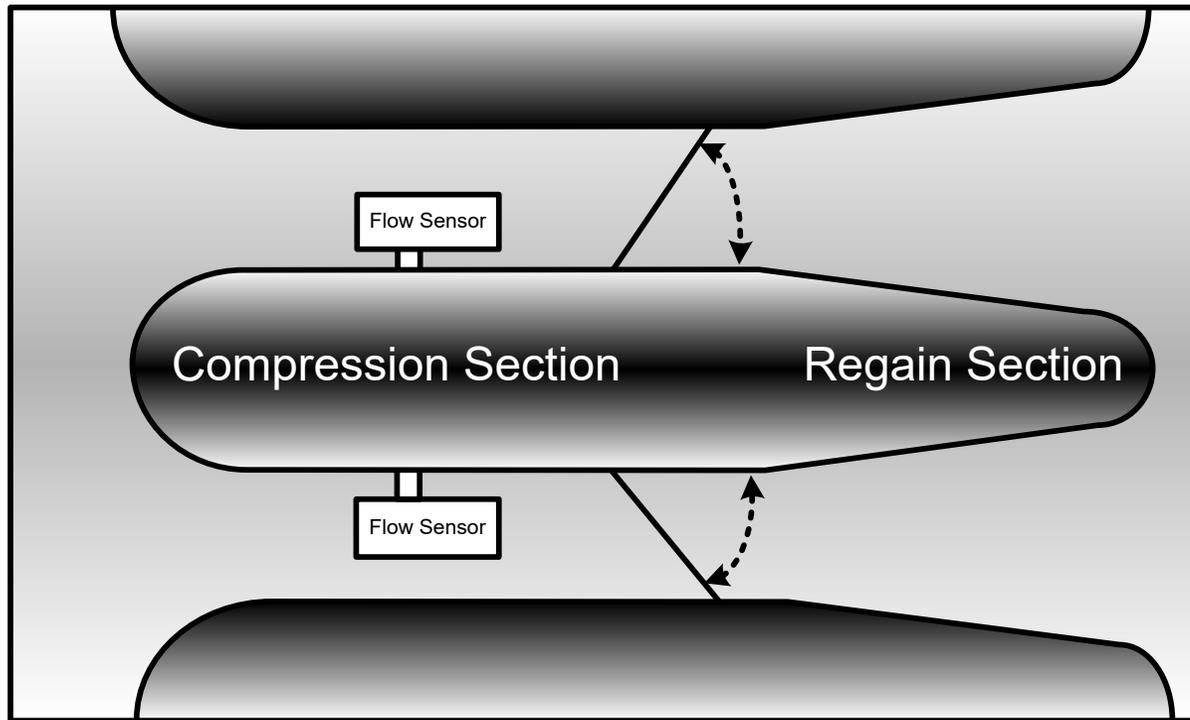


Single Blade Venturi



Dual Blade Design

Air Valve Technologies – Dual Blade Design

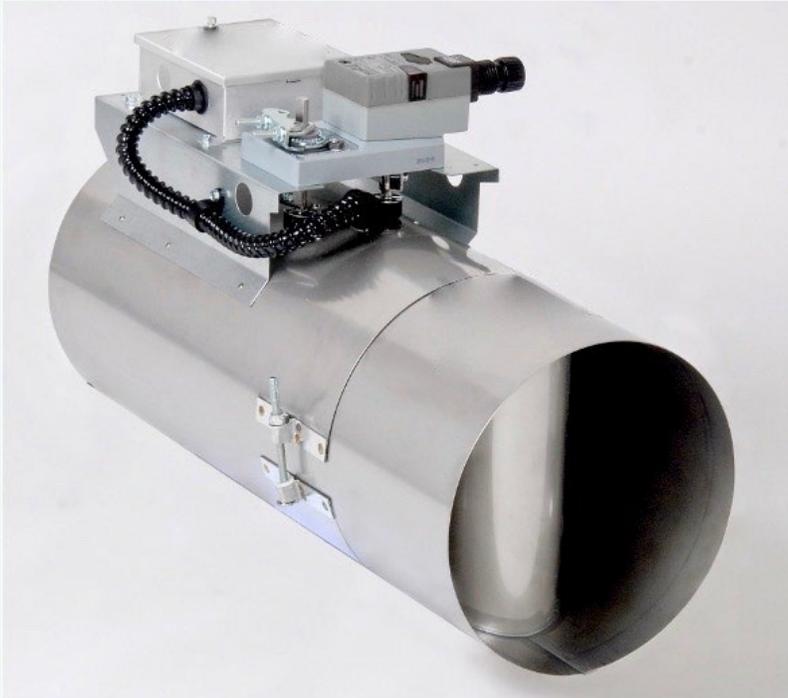


Air Valve Technologies – Dual Blade Design

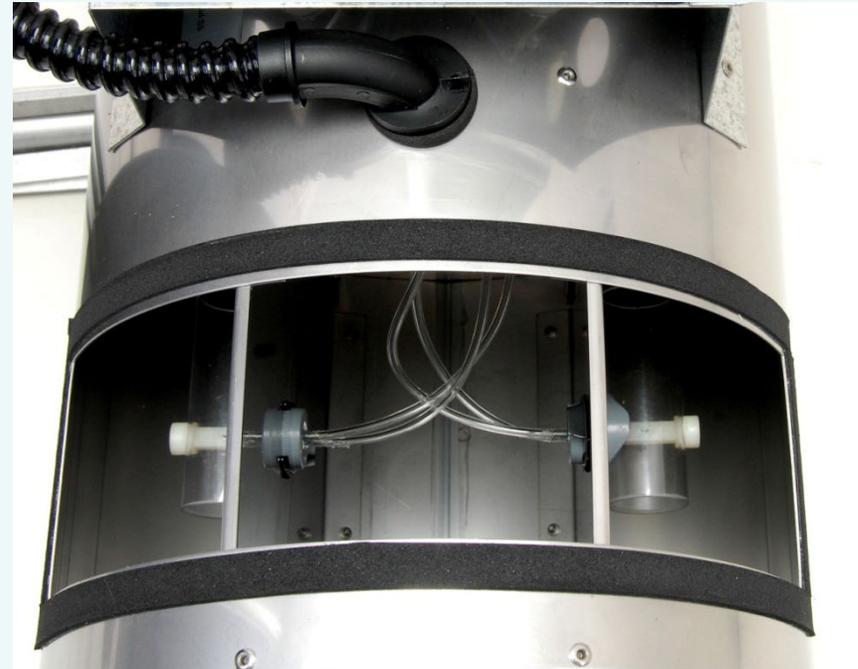
Critical Parts are
OUT of the Airstream

Airflow
Transmitter

Actuator



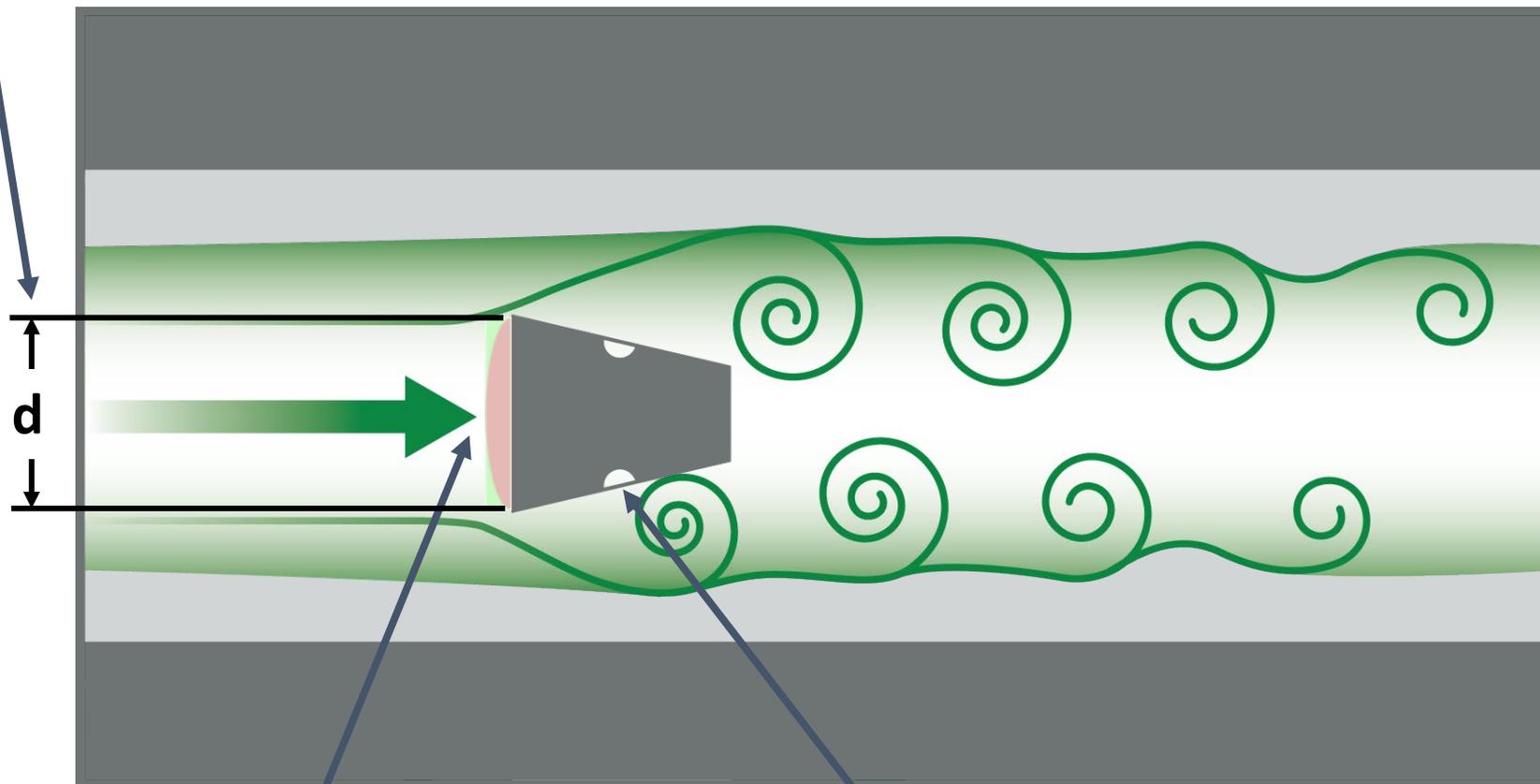
Access Panel for Inspection



Air Valve Technologies – Dual Blade Design

“d” Doesn’t Change

Therefore Accuracy Doesn’t Change



d

Possible Slight Buildup

Self Cleaning due to
Negative Pressure Eddie

R1 Pilot Project – Jan 2019

✓ No Static Pressure Requirements!



The Challenges – Retrofit an Active Vivarium

A Critical System in a High-Stakes Environment

- Replace 145 supply air and 174 exhaust air valves(319 air valves total)
- 186 rooms, 47K sq ft
- Contractor only gets 3-5 rooms at a time to retrofit for each phase broken down into multiple MOPs(Method Of Procedure)
- Each MOP must be completed in two weeks or less
- No call backs after commissioning!

The Solutions – Retrofit an Active Vivarium

How we accomplished it

- A dedicated team with the same individuals for every MOP
- BACnet address coordination prior to air valve release

Site Name	BLN Name	Panel Name	Device Instance Number	Network ID
RC1	P18-EBLNB	LGT-P18-01-001	3017031	
RC1	P18-EBLNB	BAS-P18-IN-042	3017041	
RC1	P18-EBLNB	BAS-P18-IN-043	3017044	
RC1	P18-EBLNB	BAS-P18-IN-044	3017045	
RC1	P18-EBLNB	BAS-P18-IN-045	3017046	
RC1	P18-EBLNB	LDT-P18-09-001	3017099	
BASP18IN044	MAC address ALN 1	Device Instance Number	Network ID	Device Type
SAV-P18-IN-036	1	3017167	50496	Accutrol
SAV-P18-IN-033	2	3017168	50496	Accutrol
SAV-P18-IN-031	3	3017169	50496	Accutrol
SAV-P18-IN-032	4	3017170	50496	Accutrol
SAV-P18-IN-034	5	3017171	50496	Accutrol
SAV-P18-IN-035	6	3017172	50496	Accutrol
SAV-P18-IN-144	7	3017173	50496	Accutrol

The Solutions – Retrofit an Active Vivarium

How we accomplished it

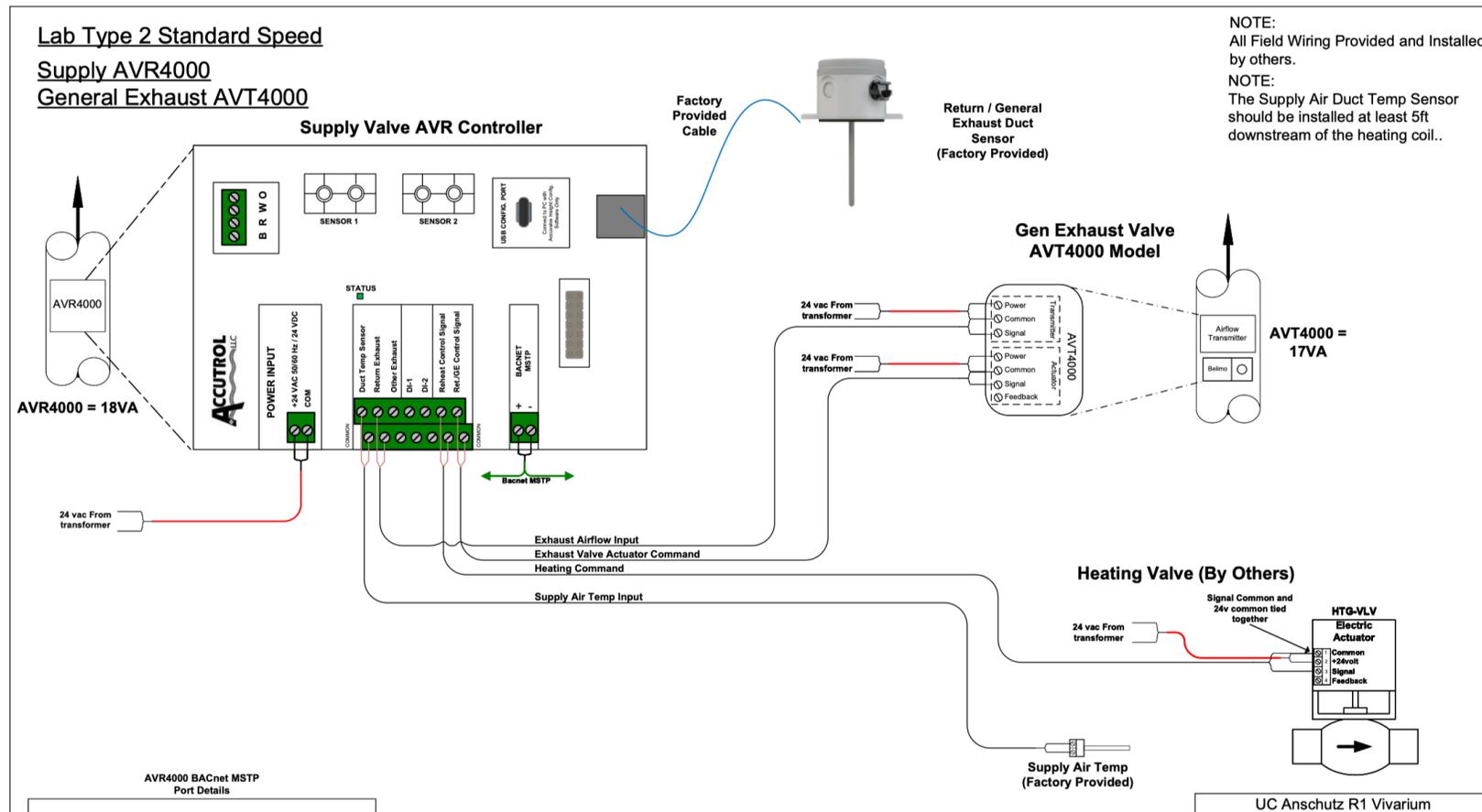
- Factory program all of the replacement air valves and verification on air test tunnel



The Solutions – Retrofit an Active Vivarium

How we accomplished it

- Simplified wiring diagrams that are repeatable for each MOP



The Solutions – Retrofit an Active Vivarium

How we accomplished it

- Simple checklist for the mechanical contractor to perform both the Installation Verification and Operational Verification

CONTRACTOR STARTUP CHECKLIST

To the Mechanical Contractor: The items in Column B that need your attention are marked with a (check box). Upon completion of each item, please place your initials in the adjacent Column A and an “X” in Column B.

A	B	
		Installation Verification
_____	<input type="checkbox"/>	Confirm the air valves in the duct are installed in the correct air flow direction orientation.
_____	<input type="checkbox"/>	Confirm the draw band clamps (DBC) for the air valves have the DBC notch installed on the air valve and not butted up to the air valve and the appropriate sealant tape was used, UL181 for non-corrosive and PTFE for corrosion applications (if applicable).
_____	<input type="checkbox"/>	Confirm the rectangular air valves flanges have been sealed with appropriate duct sealant (if applicable).
_____	<input type="checkbox"/>	Confirm the Discharge Air Temperature (DAT) sensor is installed mid-way in the vertical duct just prior to the first duct tap and 3’ or better from the reheat coil. If 3’ is not available, DAT sensor to be installed as far down as possible just prior to the first duct tap.
_____	<input type="checkbox"/>	Confirm room temperature sensor is installed on the wall for all Supply air valves (if applicable).
_____	<input type="checkbox"/>	Confirm exhaust temperature sensor is installed in the general exhaust, for room without cage racks (if applicable).
_____	<input type="checkbox"/>	Confirm exhaust temperature sensor is installed in the cage rack exhaust after all cages taps have entered the manifold for room with cage racks (if applicable).
_____	<input type="checkbox"/>	Check that the factory shielded, plenum rated CAT5e wire from the supply air valve to the temperature sensor is not damaged and the excess is coiled up.
_____	<input type="checkbox"/>	Check that all valve covers are installed in place and excess wiring is coiled up and secured.
_____	<input type="checkbox"/>	The contractor agrees that the Accutrol System is installed per the Accutrol Submittal Documentation and Accutrol Project Specific Wiring Diagrams.

The Solutions – Retrofit an Active Vivarium

How we accomplished it

CONTRACTOR STARTUP CHECKLIST

Cage Rack or Other Exhaust Valves (EAV) Operational Verification (if required)

- Plug into the air valve with a USB-C to USB cable and open the Insight Software.
- Confirm airflow set point is being achieved and Analog Output #1 operation for constant volume devices.
- Save the configuration file to flash (if any changes were made).
- Save the configuration file to the laptop hard drive and name the file the valve tag.
- Close out of the software and unplug from the air valve.
- Return the air valve cover.

Airflow Control Valves (SAV and EAV) Operational Verification

- Plug into the air valve or room temperature sensor with a USB-C to USB cable and open the Insight Software.
- Open the Reheat Control set point tab and change the Reheat control from Direct to Indirect.
- Confirm all airflows are controlling per schedules for SA, GEX, and Other Exhaust as applicable.
- Confirm the system is controlling to the scheduled volumetric offset cfm.
- Confirm the DAT sensor is reading a reasonable temperature and not 48F or 147F, which would be an open wire or bad sensor.
- Force the general exhaust valve 100% open via the manual mode button and confirm the measured air flow reading increases and supply air valves tracks the exhaust air valve.
- Put the general exhaust valve back in Auto mode after the forced test.
- Force the Reheat Valve (RHV) signal to 100% open and confirm the DAT starts to rise.
- Force the Reheat Valve (RHV) signal to 0% open and confirm the DAT starts to drop.
- Put the Reheat Valve (RHV) signal back in Auto mode after the forced test.
- Confirm the BMS can change the Mode for the rooms that have more than one mode.
- Save the configuration file to flash (if any changes were made).
- Save the configuration file to the laptop hard drive and name the file the valve tag (if any changes were made).
- Close out of the software and unplug from the air valve.
- Return the air valve cover or replace the USB-C cover if plugged into the room temperature sensor.

The Solutions – Retrofit an Active Vivarium

How we accomplished it

- Free software for the mechanical contractor and air balancer to interface with the air valves



The Solutions – Retrofit an Active Vivarium

How we accomplished it

- Remote commissioning thru integration

Test Results w/Chart Test Test Chart Airflow Dashboard

Select a Phase from the picker and then a Test from the table:

Vivarium Phase | MOP

1 MOP #3

FPT Type	Lab	Setpoint 1	Value 1	Setpoint 2	Value 2	Runtime 1
Lab Heat Mode 2	Research 1 Rm438	Mode Status	2	Mode 2 Room Temperature Heating Set Point	85°F	28-Jan-2025 1:00pm..28-Jan-2025 1:55pm
Lab Cool Mode 1	Research 1 Rm438	Mode Status	1	Mode 1 Room Temperature Heating Set Point	65°F	28-Jan-2025 12:45am..28-Jan-2025 12:30pm
Lab Heat Mode 1	Research 1 Rm438	Mode Status	1	Mode 1 Room Temperature Heating Set Point	85°F	27-Jan-2025 12:45pm..28-Jan-2025 12:30am
Lab Cool Mode 1	Research 1 Rm440	Mode Status	1	Mode 1 Room Temperature Heating Set Point	65°F	29-Jan-2025 12:00pm..29-Jan-2025 11:45pm
Lab Heat Mode 1	Research 1 Rm440	Mode Status	1	Mode 1 Room Temperature Heating Set Point	85°F	28-Jan-2025 5:00pm..29-Jan-2025 4:45am
Lab Cool Mode 2	Research 1 Rm440	Mode Status	2	Mode 2 Room Temperature Heating Set Point	65°F	28-Jan-2025 2:00pm..28-Jan-2025 2:55pm
Lab Heat Mode 2	Research 1 Rm440	Mode Status	2	Mode 2 Room Temperature Heating Set Point	85°F	28-Jan-2025 1:00pm..28-Jan-2025 1:55pm

Question	Answer
SAV-P18-IN-058	

The Mockup

The Key to Success & Lessons Learned

- The project team selected a complex animal holding room as a mock up that was currently unoccupied to start the team initial installation process
- All interested parties met several times during the installation to inspect, correct issues, and test
- During the mockup we found wiring mistakes and issues with the initial design air flows

The Mockup

The Key to Success & Lessons Learned

- AALAC Design Airflows vs Actual Decided Airflows

SERVICE	MATERIAL	INLET DIA. (IN)	PRIMARY OPERATION		PRIM. ROOM OFFSET (CFM)	SECONDARY OPERATION		SEC. ROOM OFFSET (CFM)
			SUPPLY CFM AT 5400'	EXHAUST CFM AT 5400'		SUPPLY CFM AT 5400'	EXHAUST CFM AT 5400'	
SUPPLY	ALUMINUM	12	540		-590	1,250		+150
GEN EX	ALUMINUM	6		30			0	
CAGE RACK	ALUMINUM	12		1,100			1,100	

SUPPLY	ALUMINUM	12	710		-150	1,100		+150
GEN EX	ALUMINUM	8		260			350	
CAGE RACK	ALUMINUM	12		600			600	

Commissioning – HW Actuator/Valve Issues

The Key to Success & Lessons Learned

- During the remote commissioning, there were times that it was discovered there were issues with the existing hot water reheat actuators and/or reheat valves.

Commissioning – HW Actuator/Valve Issues

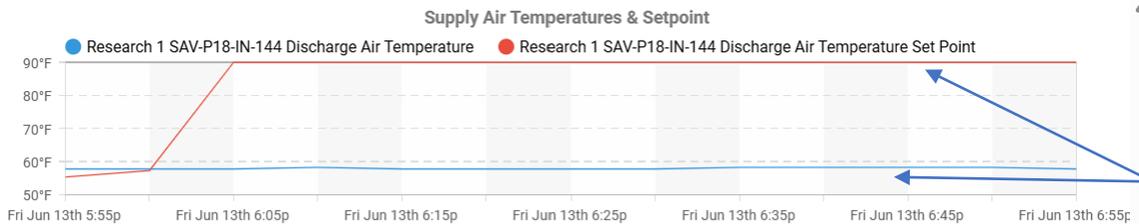
The Data-Driven Advantage: Remote Testing

- Run tests in SkySpark at any hour
- Review results
- Document issues in Facility Grid
- Contractor resolves issue
- Re-run tests immediately
- Review results to verify resolution

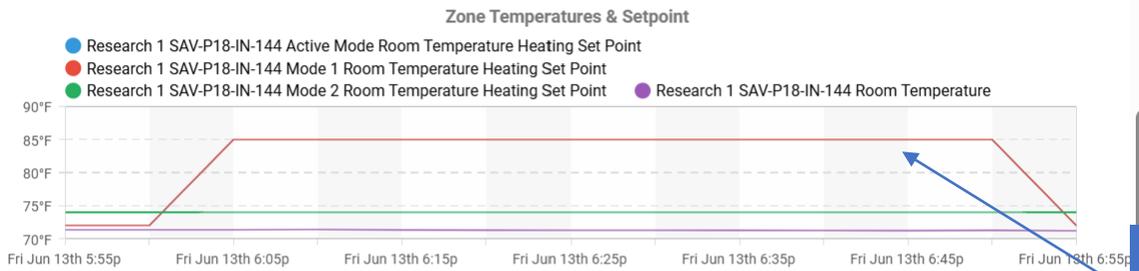
FPT Type	Lab	Setpoint 1	Value 1 ▲	Setpoint 2	
① Lab Cool Mode 1	Research 1 Rm407F	Mode Status	1	Mode 1 Room Temperature Heating Set P	
① Lab Cool Mode 1	Research 1 Rm404A1	Mode Status	1	Mode 1 Room Temperature Heating Set P	
① Lab Cool Mode 1	Research 1 Rm404	Mode Status	1	Mode 1 Room Temperature Heating Set P	
① Lab Cool Mode 1	Research 1 Rm404A2	Mode Status	1	Mode 1 Room Temperature Heating Set P	
① Lab Cool Mode 1	Research 1 Rm407C	Mode Status	1	Mode 1 Room Temperature Heating Set P	
① Lab Cool Mode 1	Research 1 Rm404B	Mode Status	1	Mode 1 Room Temperature Heating Set P	

Question	Answer	
SAV-P18-IN-083		
Does the SAV SAT SP decrease or go to minimum 55°F?	Pass	
SAT SP prior to test start:	55°F	
SAT SP 50min after test start:	55°F	
Does the reheat valve fully close?	Pass	
Reheat valve position prior to test start:	0%	
Reheat valve position 50min after test start:	0%	
Does the SAT meet the SAT SP (within 2Δ°F) after 50min?	Fail	
SAT SP 50min after test start:	55°F	
SAT 50min after test start:	93°F	
Does the zone temp change more than 4Δ°F over the 50min test period?	Fail	
Zone Temp at the start of the test:	74.48°F	
Zone Temp 50min after test start:	74.49°F	
Is the supply cfm setpoint maintained?	Pass	
Supply air flow setpoint 50min after test start:	226cfm	
Supply air flow 50min after test start:	230cfm	
Is the zone cfm offset maintained?	Pass	
Zone cfm offset setpoint 50min after test start:	-160cfm	
Zone cfm offset 50min after test start:	-155cfm	
Verify the air valve does not hunt (change position more than 10% more than 4 times within 50min)?	Pass	
Verify the reheat valve does not hunt (change position more than 10% more than 4 times within 50mi...)	Pass	
EAV-P18-IN-092		
Does the Exhaust Flow meet the Exhaust Flow SP (within 100cfm) after 50min?	Pass	

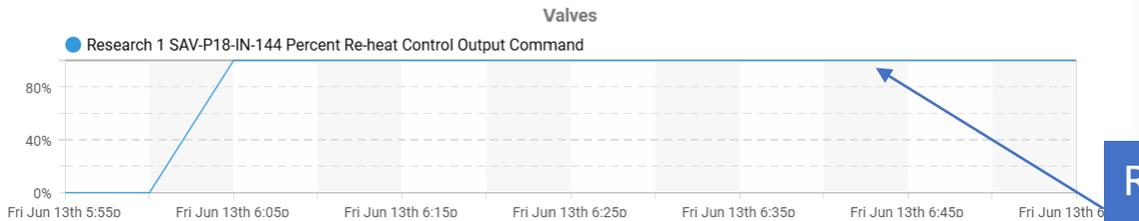
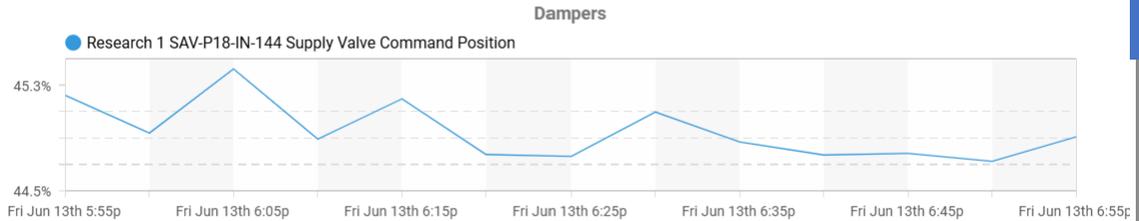
Commissioning – HW Actuator/Valve Issues



DAT did not increase



Room temperature setpoint was set to 85degF

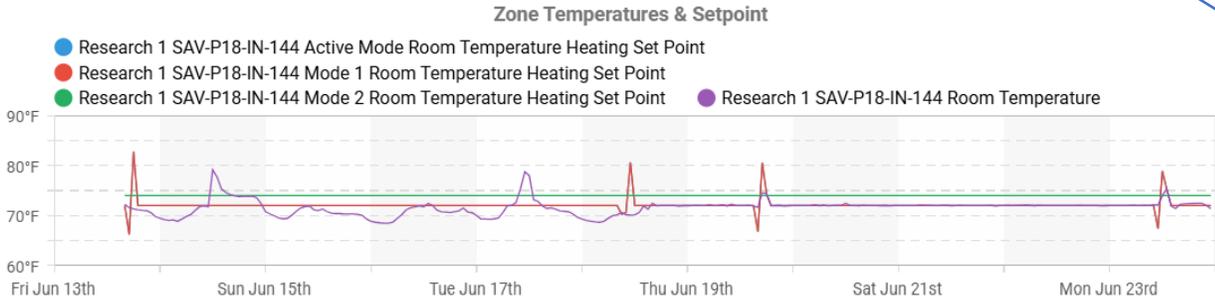
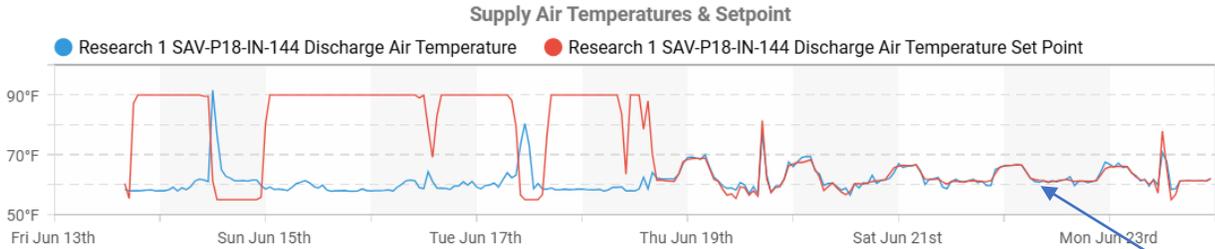


Reheat valve commanded to 100%

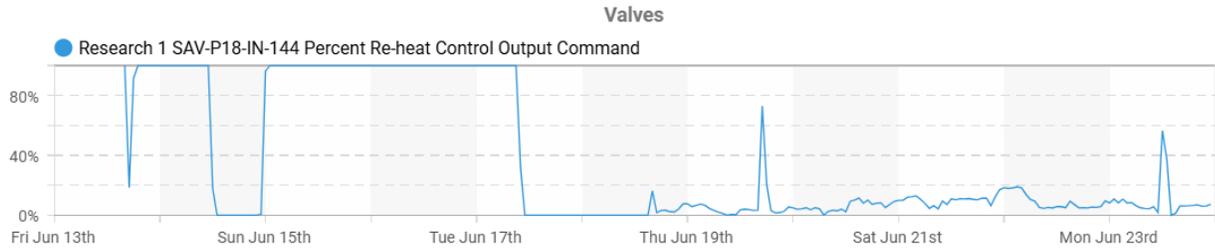
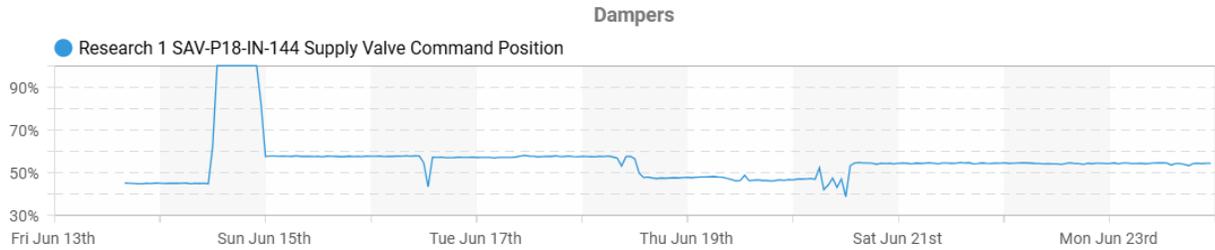
Commissioning – HW Actuator/Valve Issues

Retests were run

Valve was cycled, re-wired

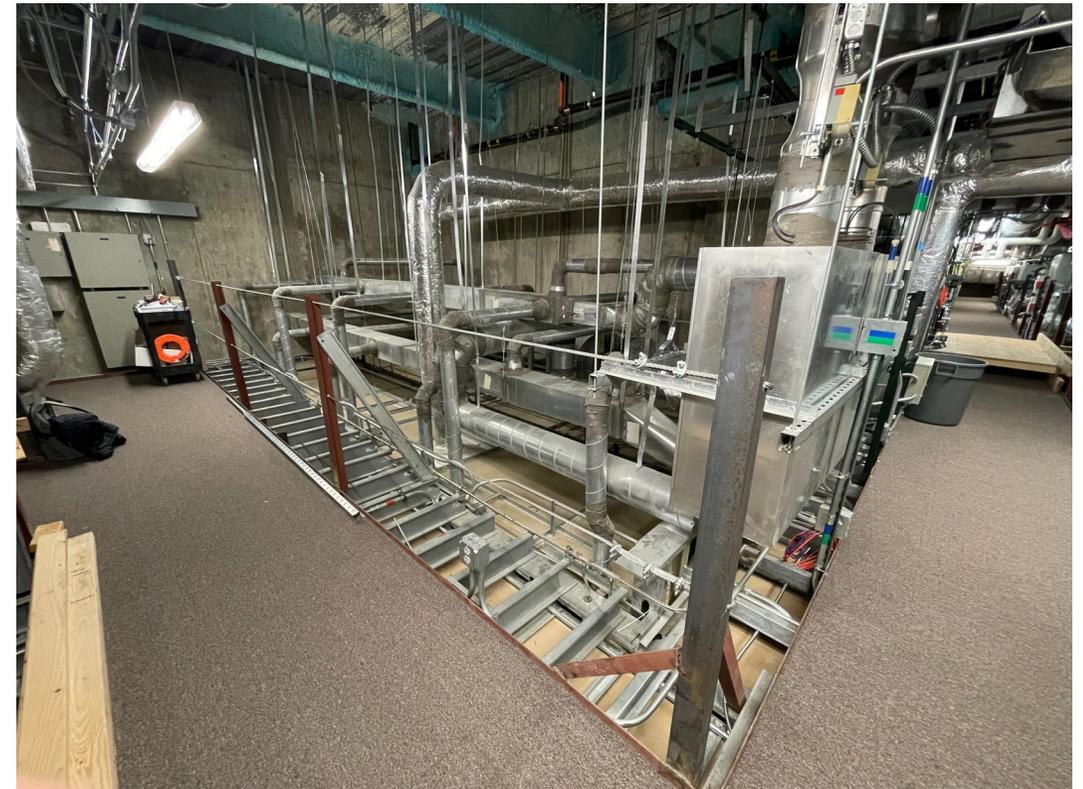
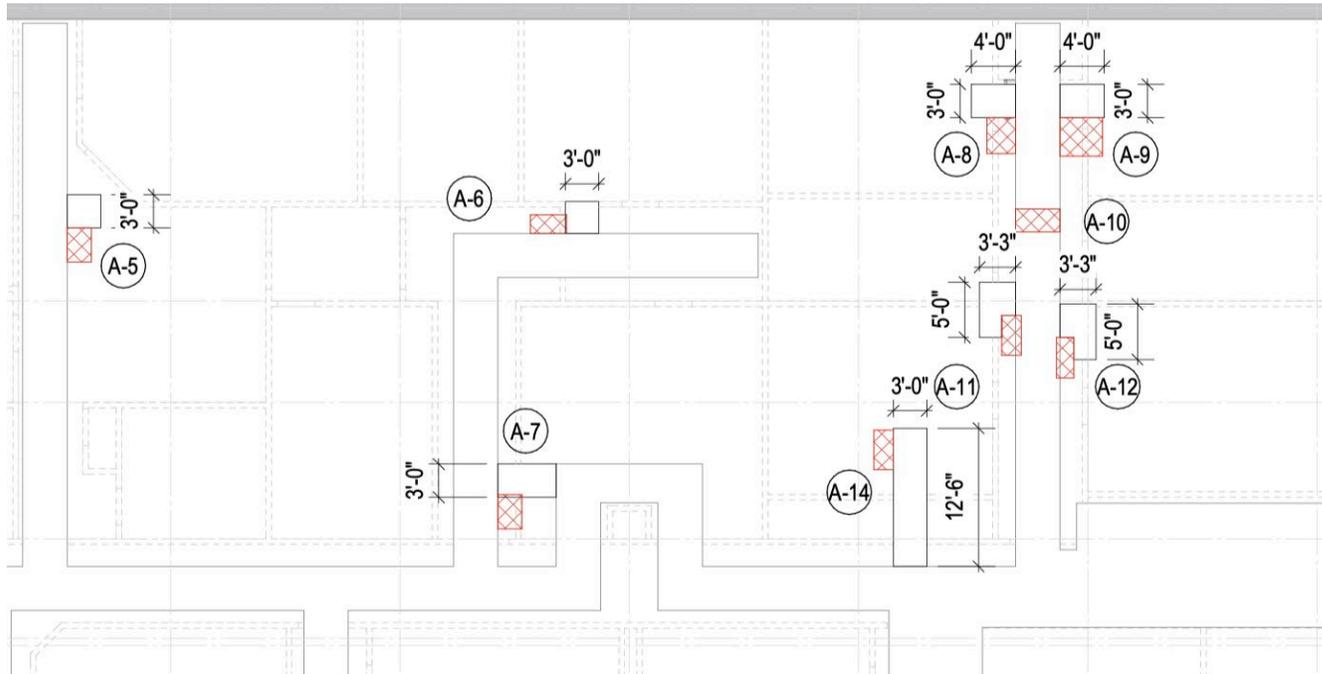


Now the valve is controlling to setpoint

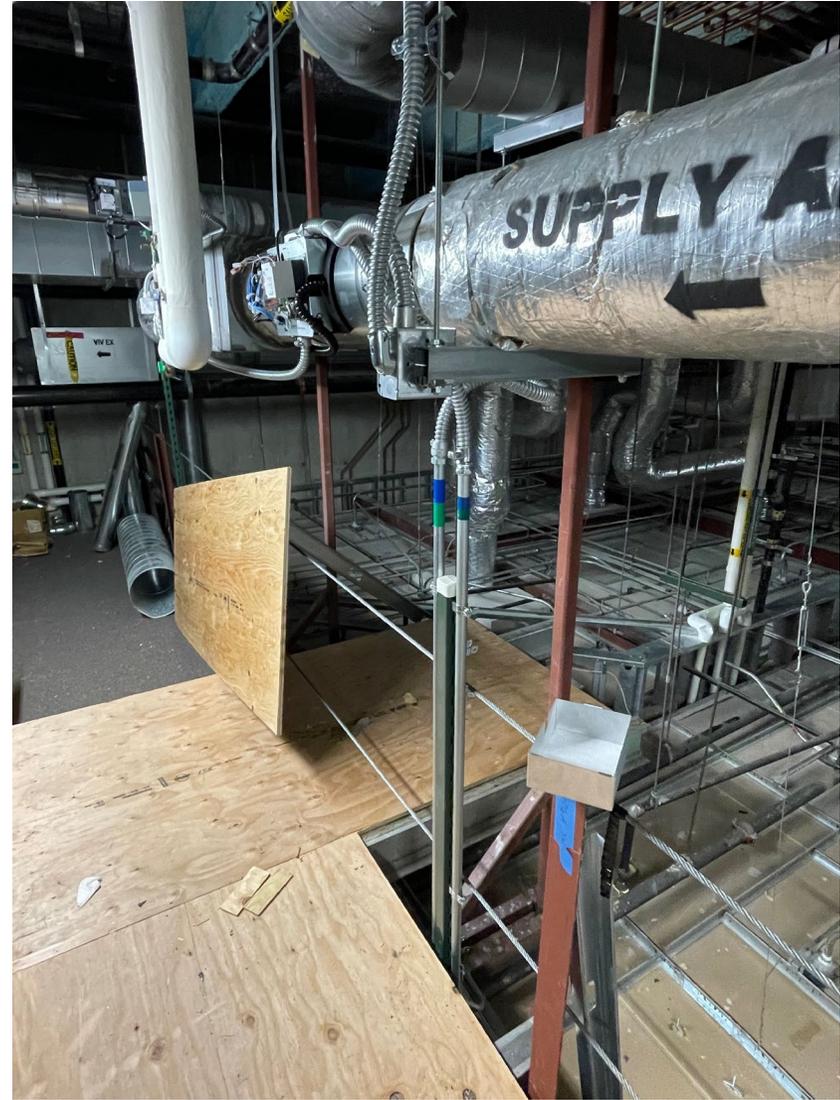


Scaffolding – Lessons Learned

- The contractor used a lot more scaffolding than the design team initially considered.
- We could have received additional funding from the State Architect for Temporary Scaffolding



Scaffolding – Lessons Learned





Thank You!

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