U.S. DEPARTMENT of ENERGY | Federal Energy Management Program

Advanced Building Automation: Cutting Edge of Controls

T04-S05, August 6th, 2025

FEMP Summer CAMP (Courses Aligned with Mission Priorities)

Devon Rock

Project Director

Office of the Deputy Assistant Secretary of Army

Agenda

- Session Learning Objectives
- Control System Readiness
- Enhanced Interfaces
- Fault Detection and Diagnostics
- Optimized Control Systems
- Conclusion and Q&A

Session Learning Outcomes

1. Identify new standards and best practices in HVAC controls, including point naming conventions and graphical interface improvements
2. Recognize the role of fault detection and diagnostics in optimizing building performance
3. Evaluate current control system configurations and identify opportunities for enhancement
4. Apply advanced control strategies to streamline operations, improve troubleshooting efficiency, and save resources

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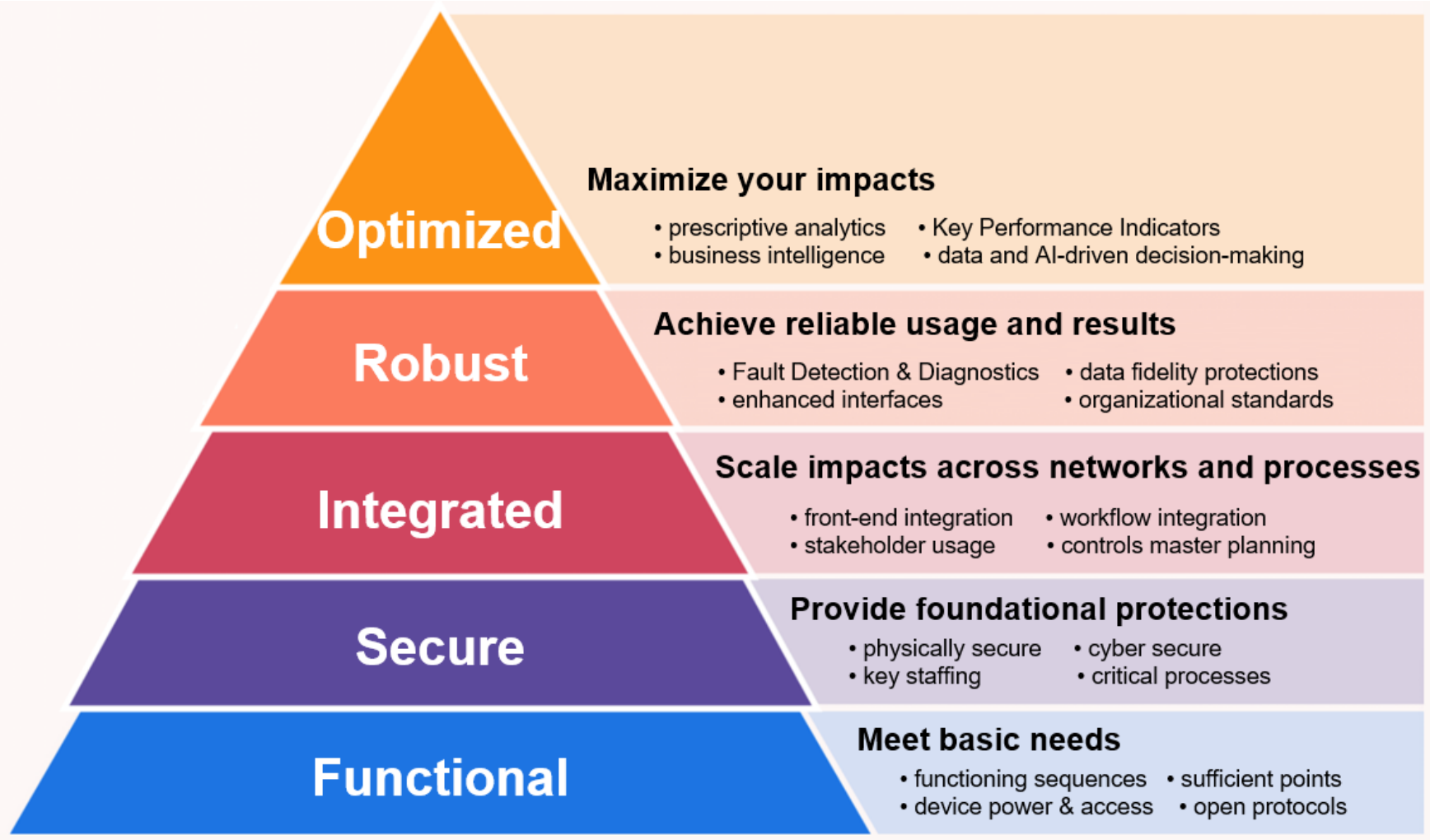
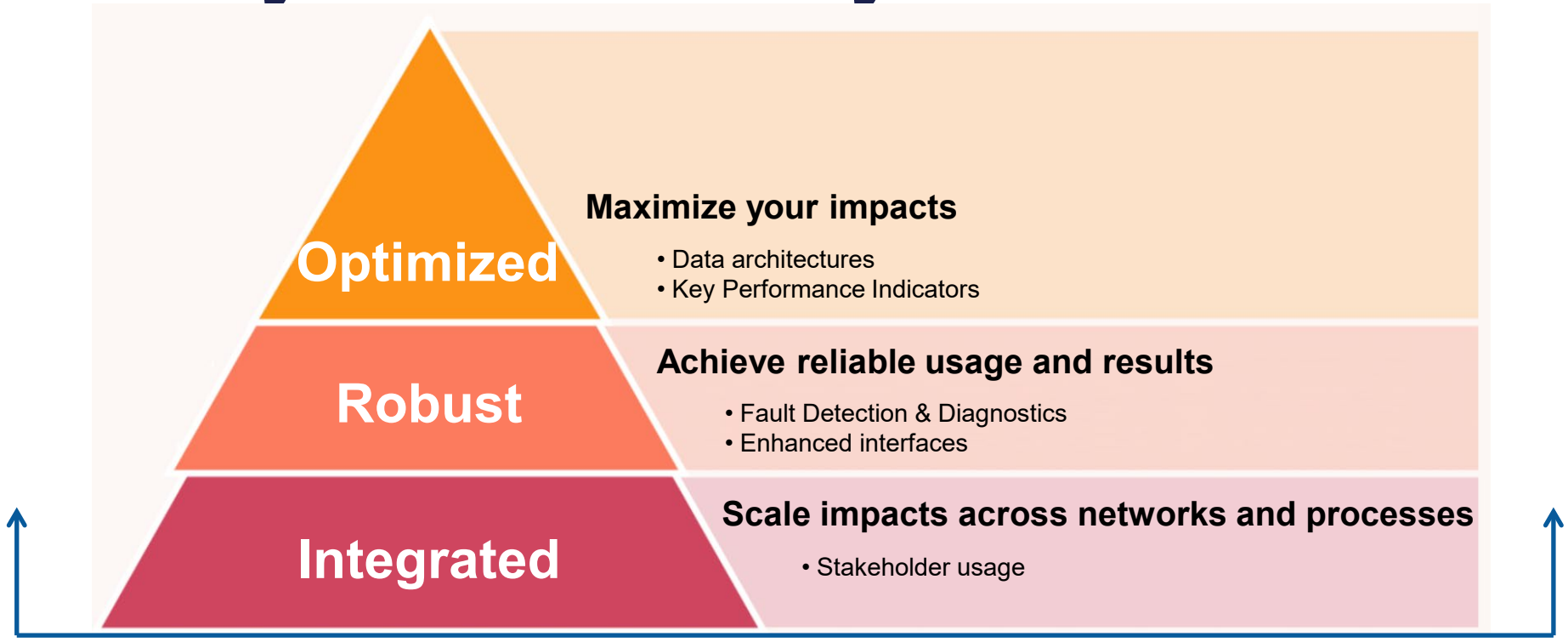
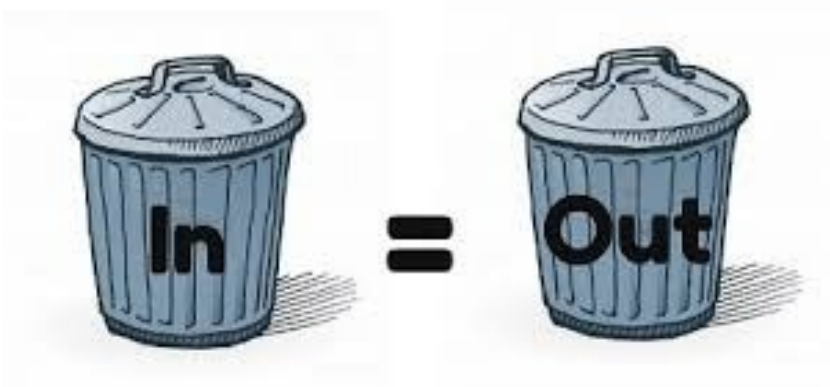
Control System Hierarchy of Needs

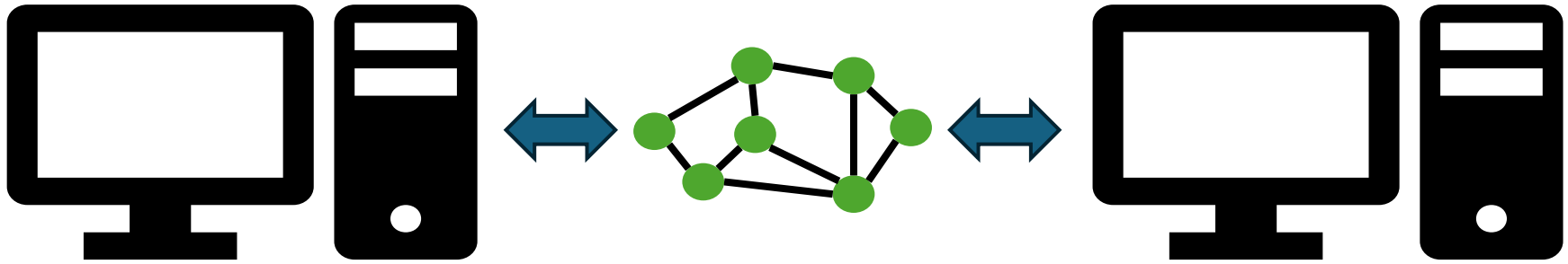


Control System Hierarchy of Needs



Importance of Data Standardization





UMCS

Work Order System

Point Schedules

Private sector projects mostly have some sort of “points list”

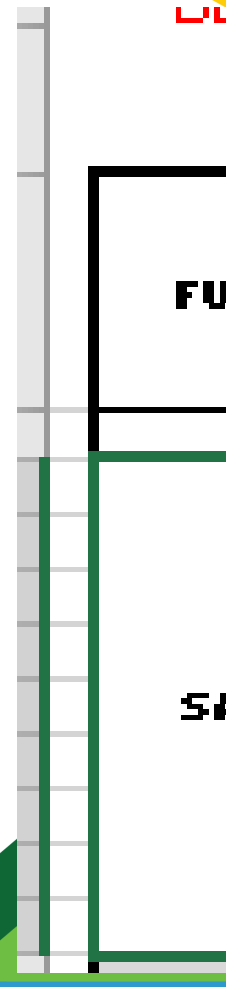
Name	Description	Type
SA-T	Supply Air Temperature	AI
SF-SS	Supply Fan Start/Stop	BO
SF-C	Supply Fan Command	AO

“Ours” is way over the top compared to “theirs”

Theirs only looks at hardware points; we look at many others

Theirs only has 3 columns; we have about 25!

Theirs is a construction document; ours is a “system lifetime” document



Point Naming Conventions

Object Name Anatomy

Building_Equipment_Object

Underscore "_" Delimiter
(Siemens legacy controllers utilize period ".")

SS#### _ EEEEEE _ PPPPPPPPPPPPPPPPPPPPPPPPPPPPPP

Building Number
Always 6 characters, always designated by GSA

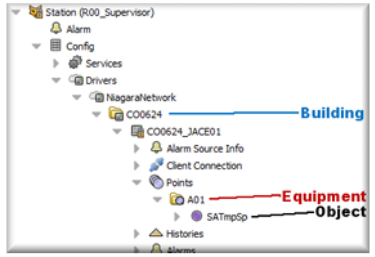
Equipment/ Location Designation
No formal standard – best practice is to use the equipment designations used in the building's mechanical drawings
Up to 6 characters as-needed

Full Name Example

CO0624_A01_SATmpSp

- CO0624 is DFC Building 810
- A01 – Air Handling Unit 1
- SATmpSp – Supply Air Temperature Set Point

Niagara Example



IMPORTANT
NEVER EXCEED 45 CHARCTERS

See ABRV page for Standard Point Name abbreviations.

See MTR page for metering object naming standard – metering objects follow a modified naming standard

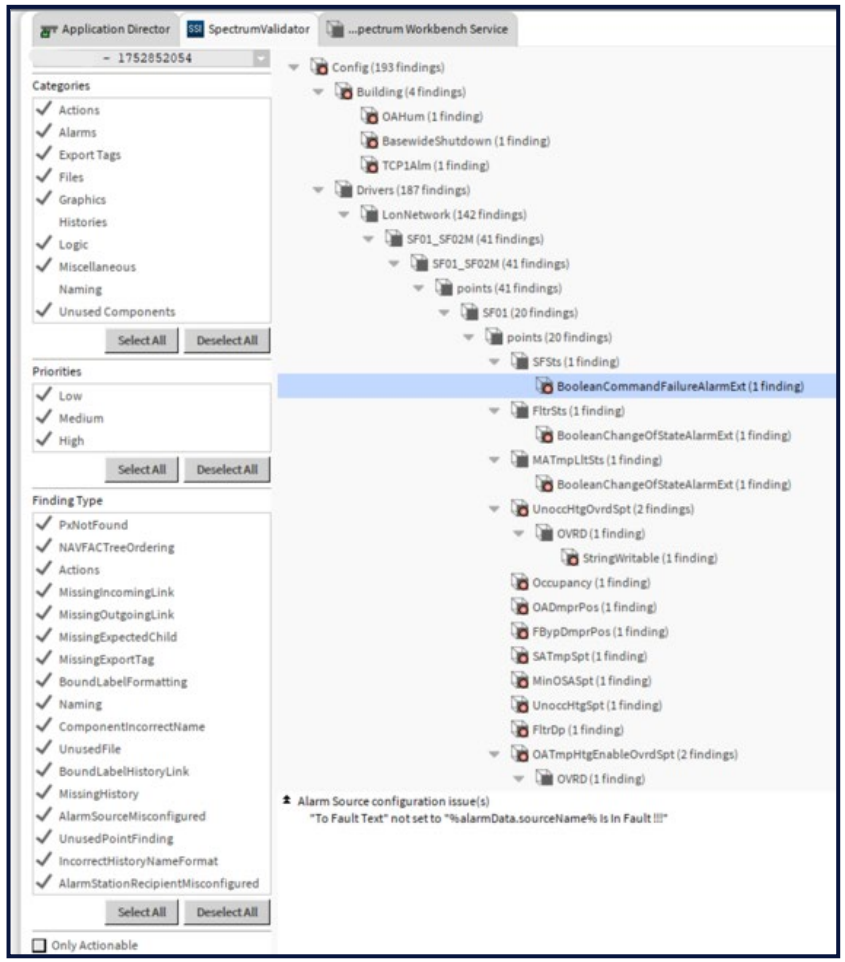
Standard Object Name

16-31 characters as-needed

Number of characters available depends on BAS product limitations. At the beginning of a project, the BAS limitation should be considered to ensure that names can be accommodated within the characters available. Some adjustments may be required.

Always use standardized names found in this document.

Automated QC Tool



Metadata

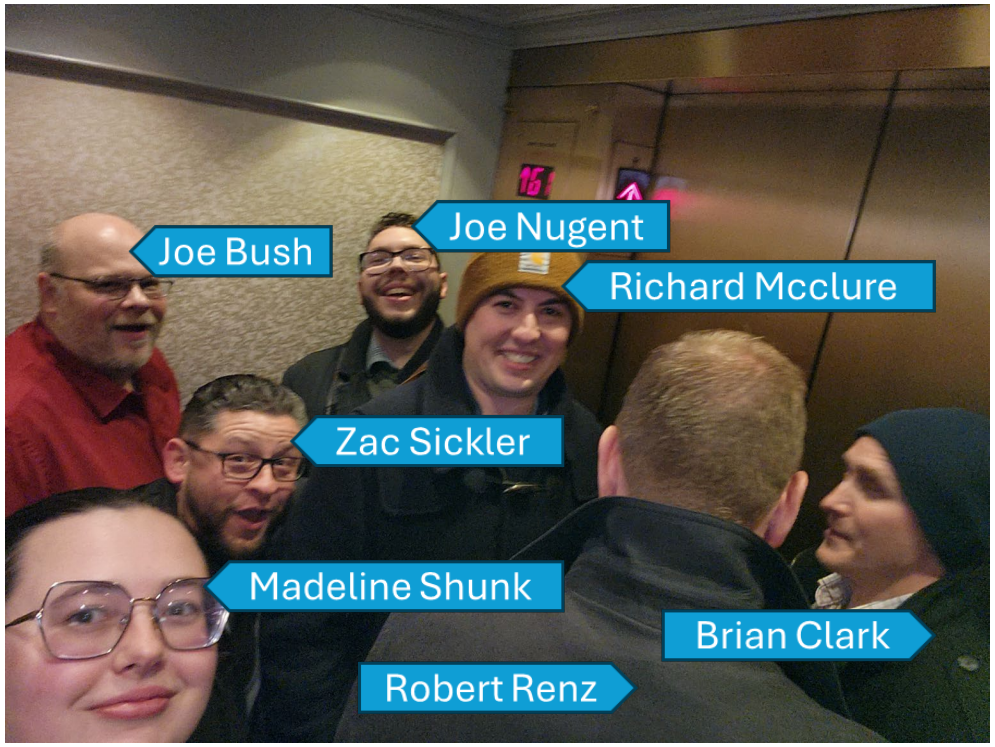
Brick Schema

ASHRAE

Project Haystack

Data About Data

Date Taken:
12/11/2024
10:07 PM

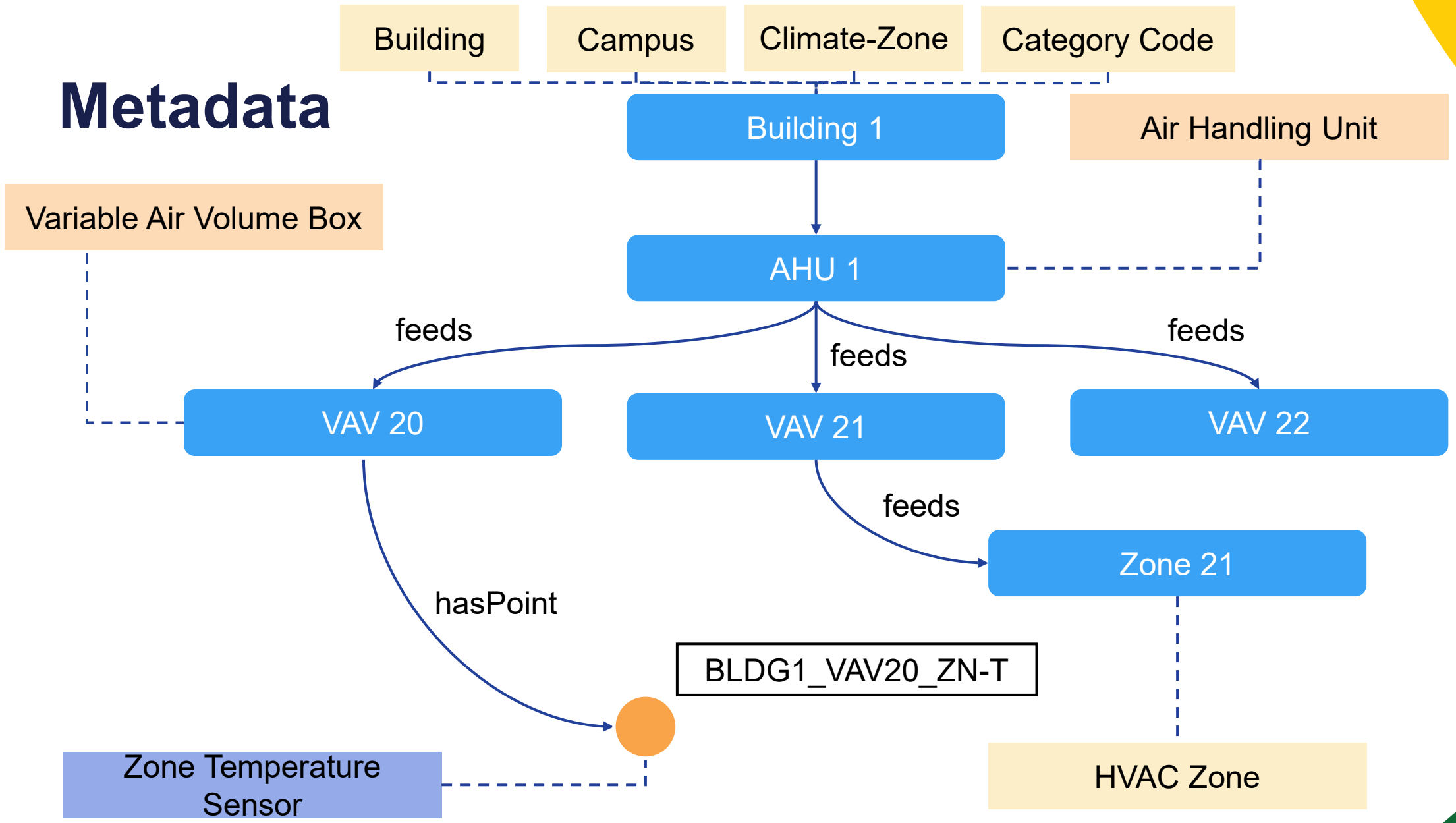


Camera Maker:
Samsung

Flash Mode:
Flash

Location:
Old Town Alexandria, VA

Metadata


Building
Campus
Climate-Zone
Category Code
Building 1
Air Handling Unit
Variable Air Volume Box
AHU 1
feeds
feeds
feeds
VAV 20
VAV 21
VAV 22
feeds
Zone 21
hasPoint
BLDG1_VAV20_ZN-T
Zone Temperature Sensor
HVAC Zone

Critical Roles Needed to Protect and Operate the Control System

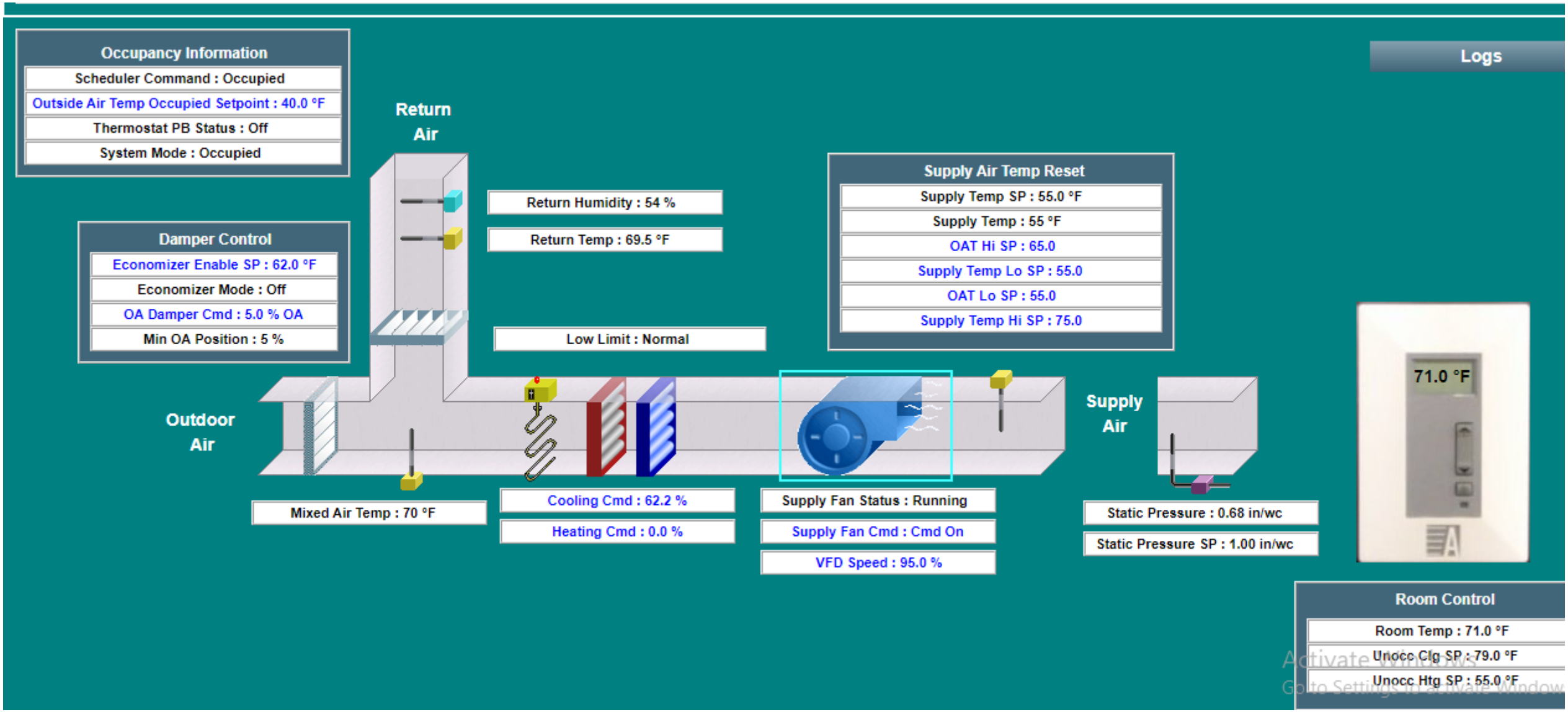
- ❑ Manager — *Authority to fund, staff, and plan building controls needs*
  - ❑ Technician — *O&M person or team to repair and sustain building controls*
  - ❑ Operator — *Regular BCS interface users to find issues or improvements*
  - ❑ Expert — *Technical advisor on BCS scoping, review, and diagnostics*
  - ❑ Integrator — *Project role for integrating BCS into a base-wide system*
  - ❑ Administrator — *IT specialist for coordinating network and cyber needs*
  - ❑ FDD Service? — *Special service role for configuring and relaying FDD?*

Must not be contracted

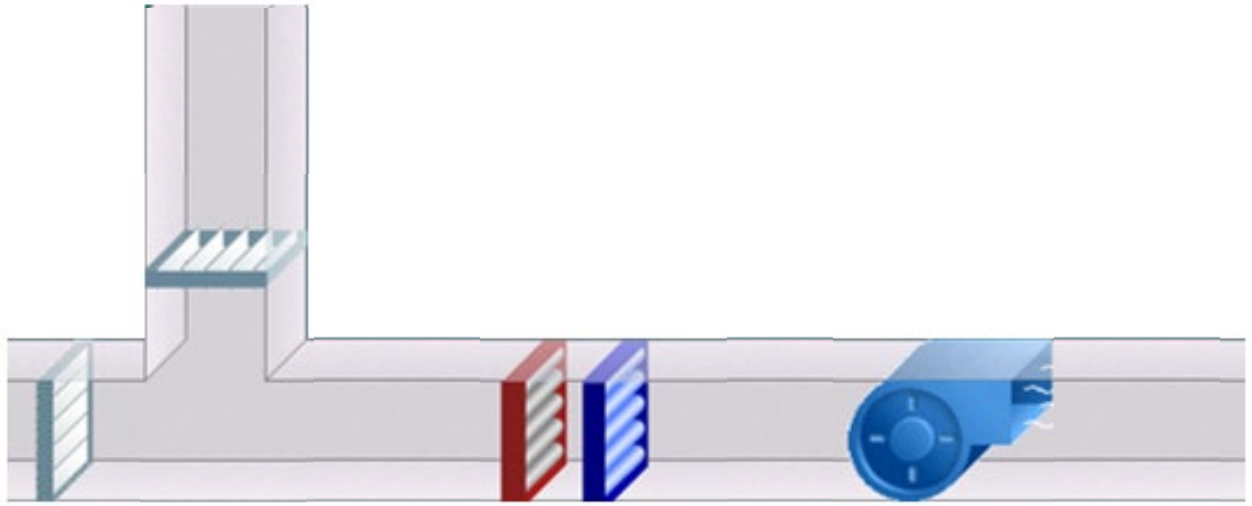
Could be contracted

Ok to be contracted

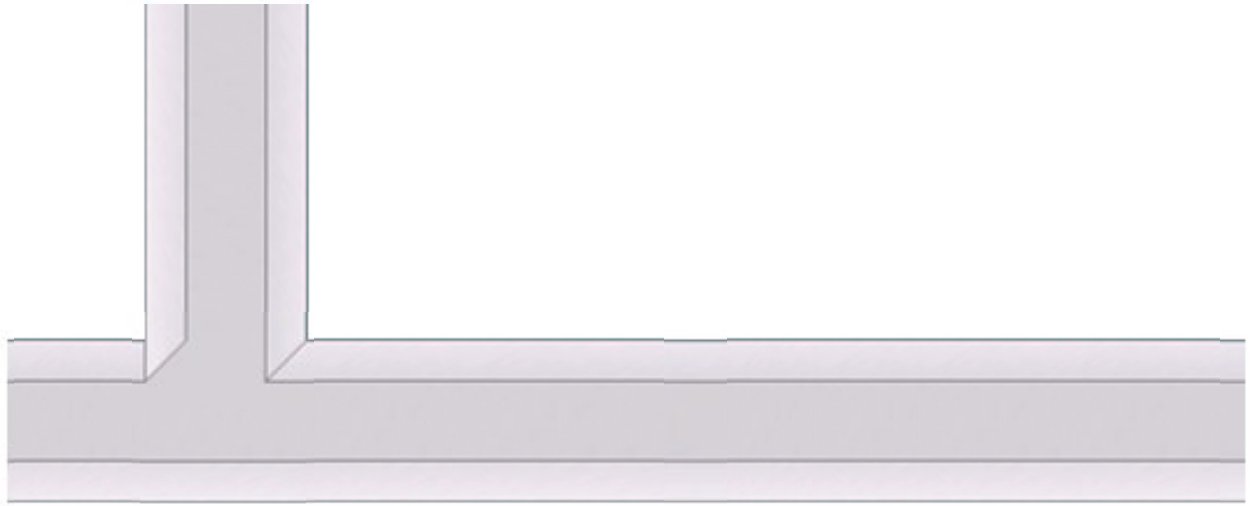
How Could We Restructure This Graphic?



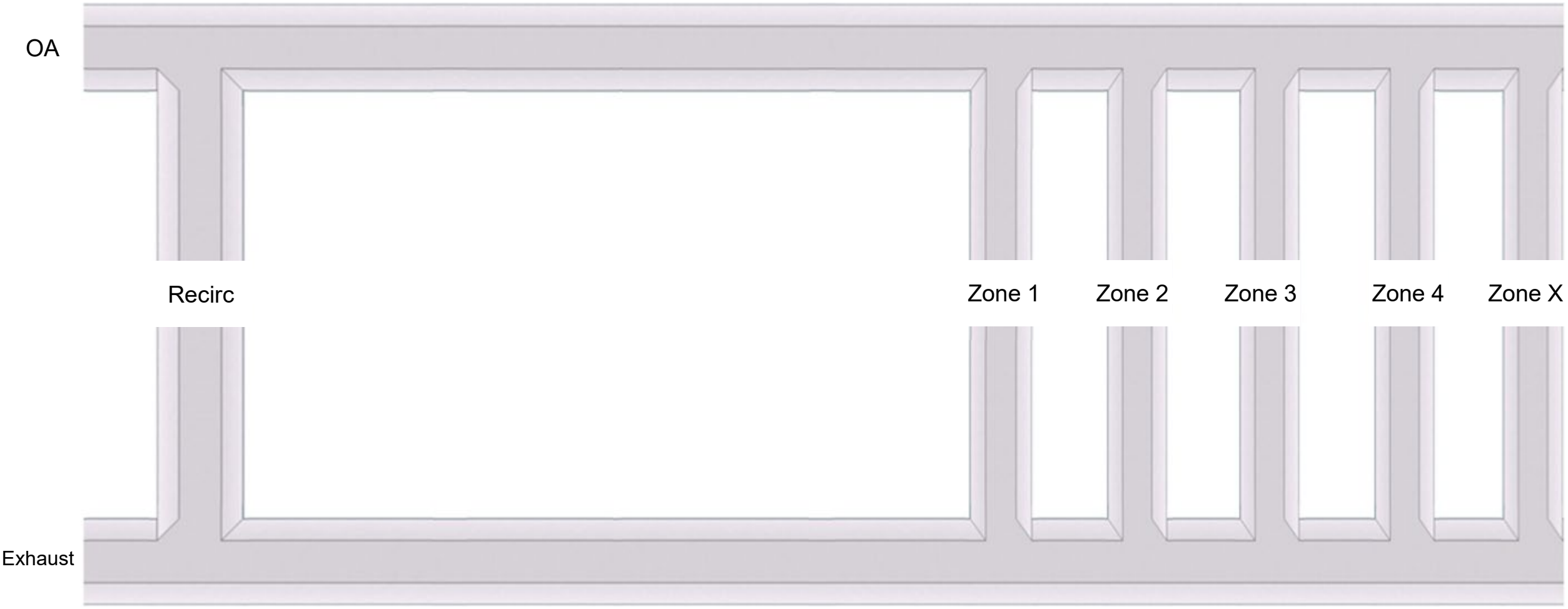
Start with Main AHU Graphic Element: AHU



Start with Main AHU Graphic Element: AHU Duct



Layout Entire Air-Side System in System Diagram Format



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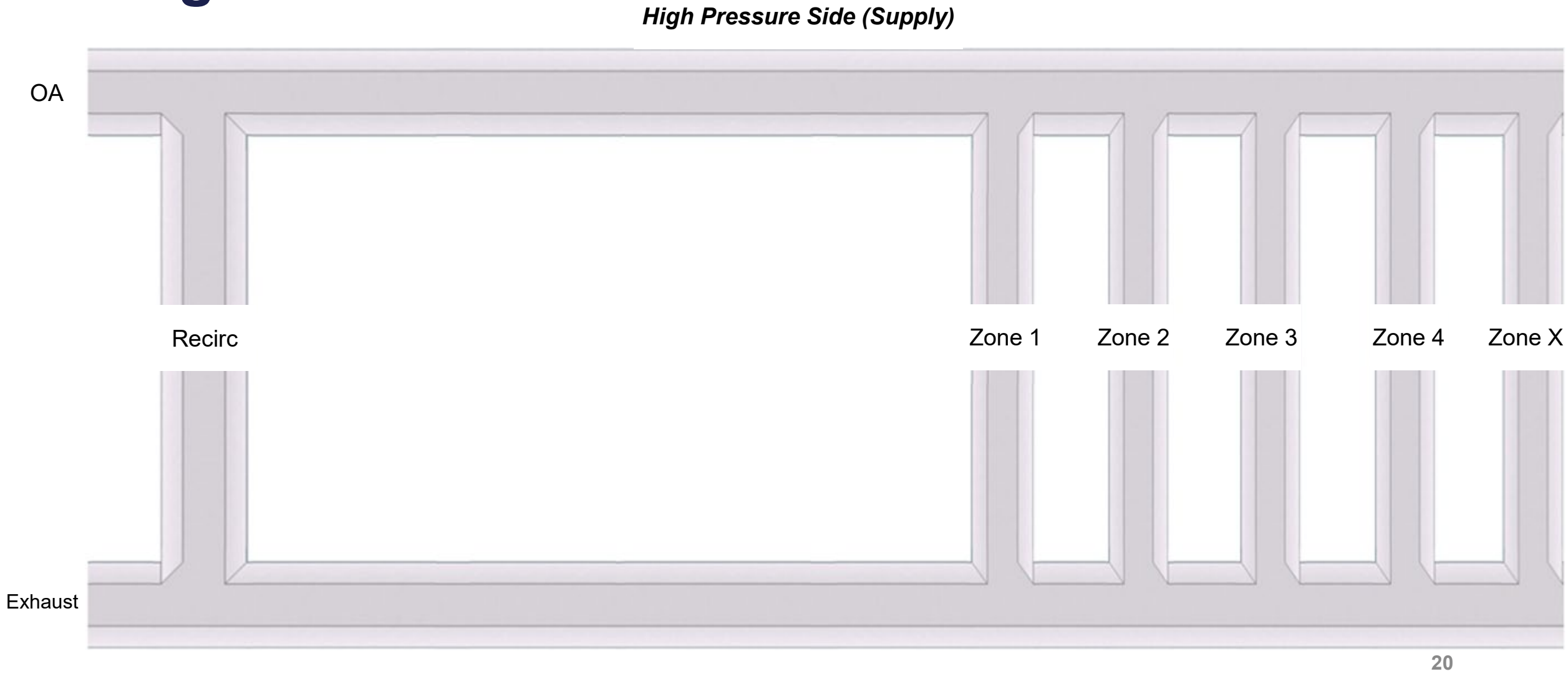

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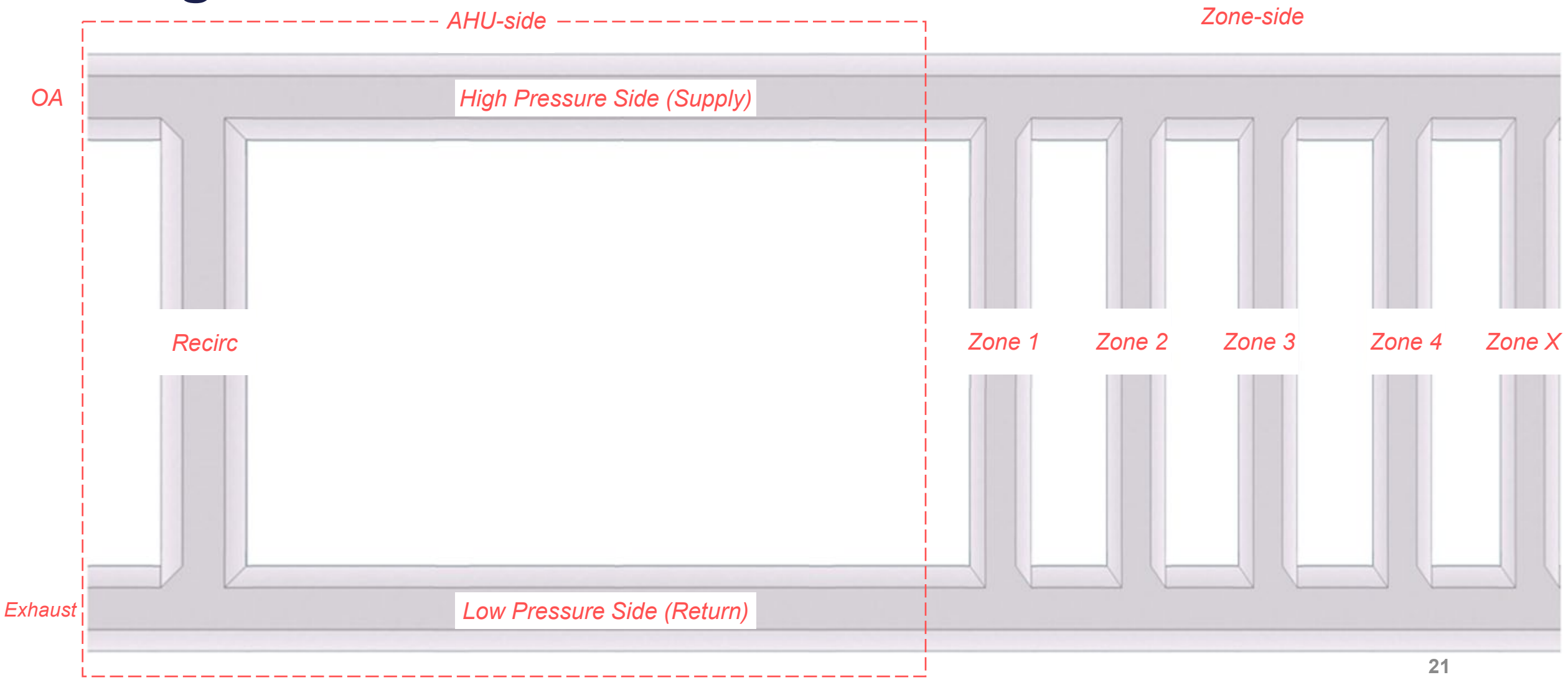

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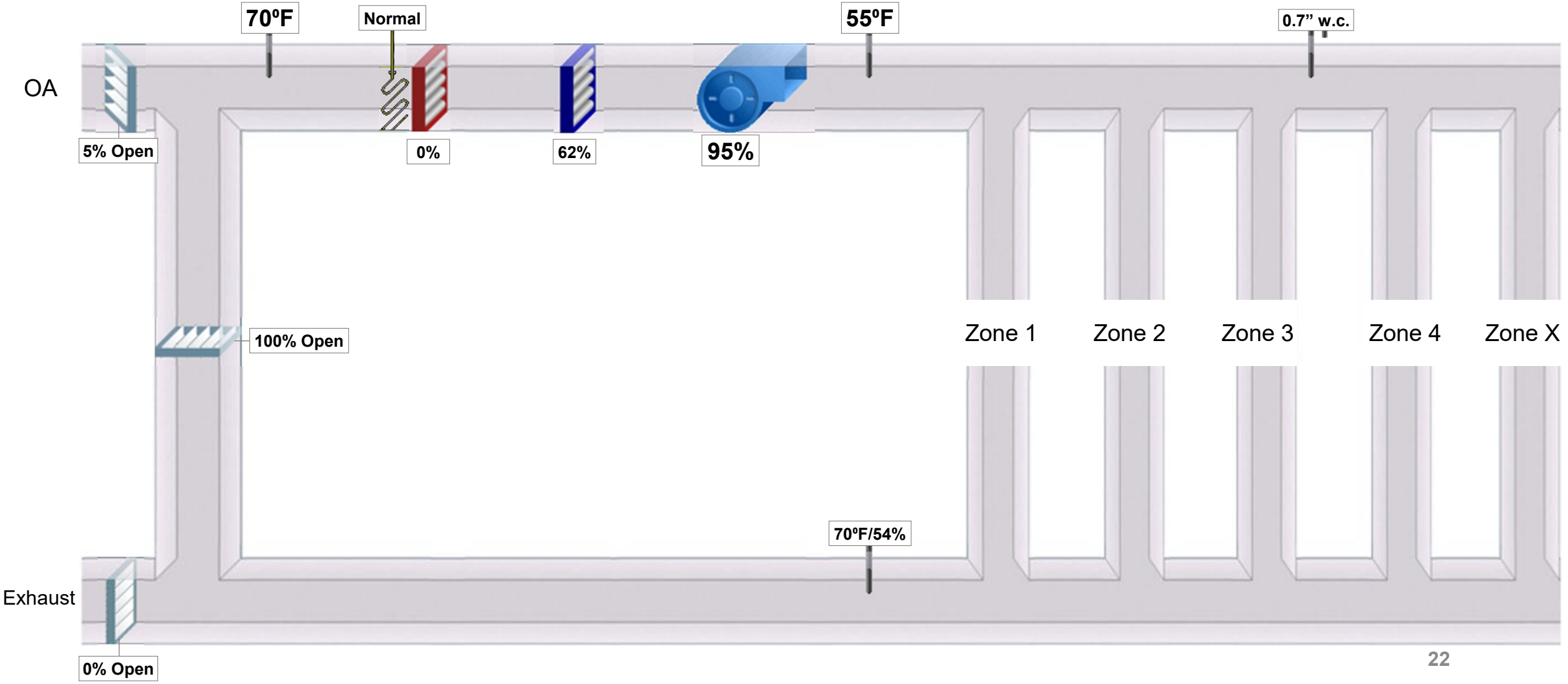
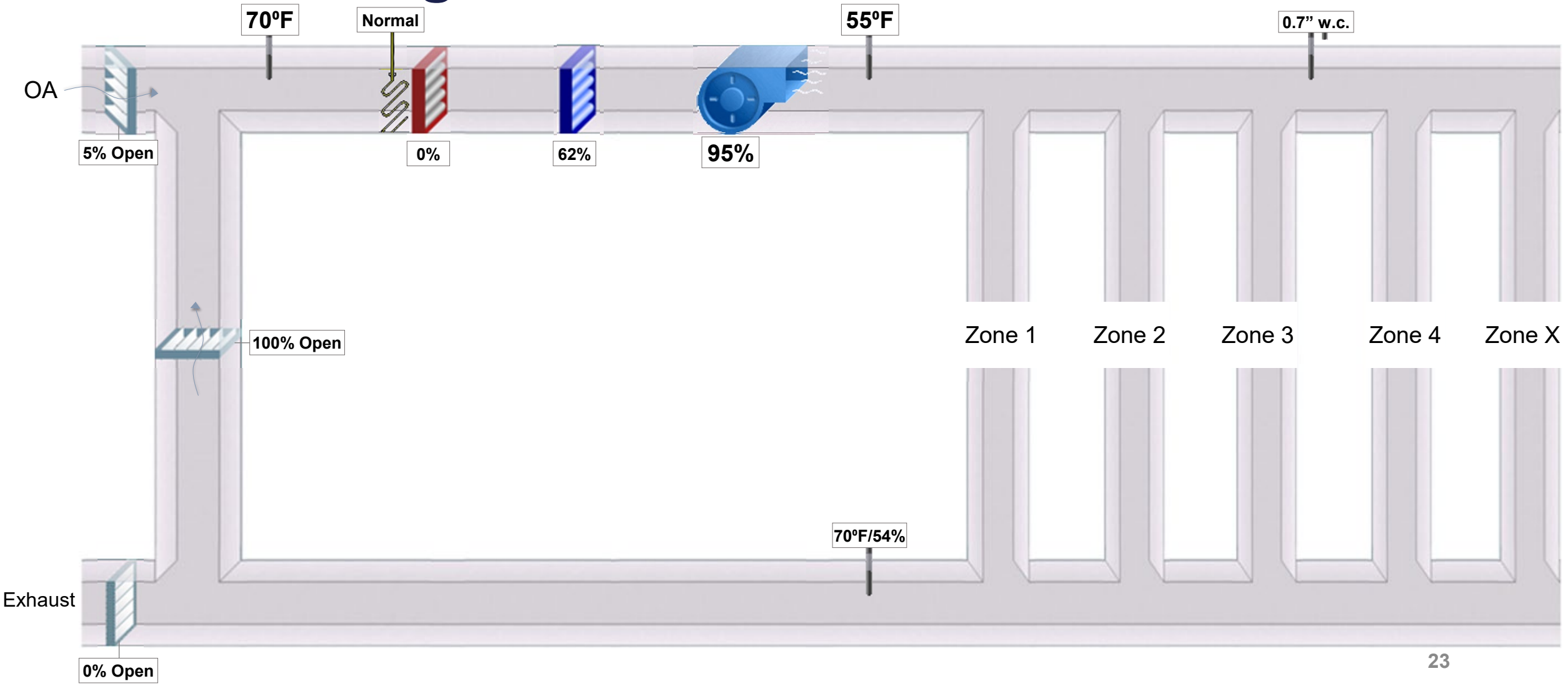
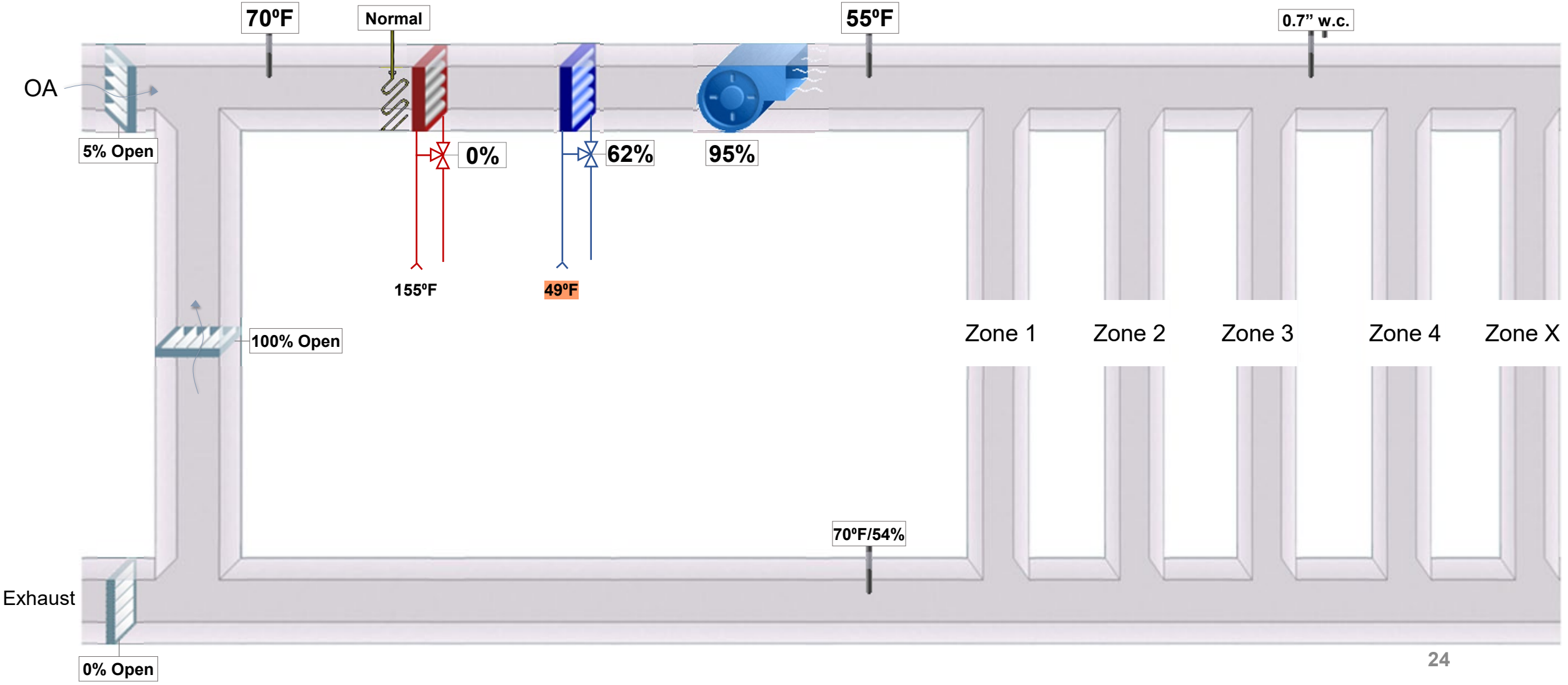


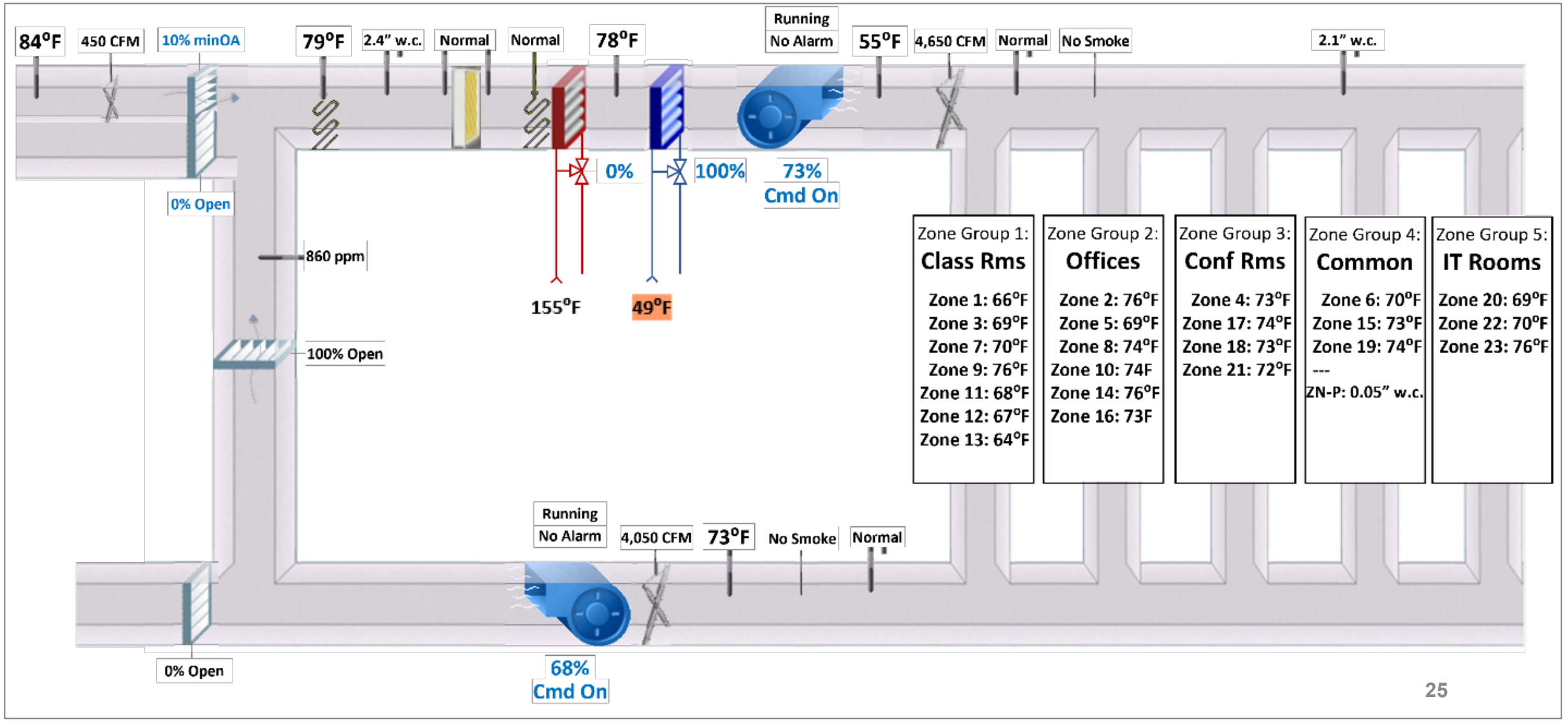
Use Light Icon Animation for Status or Value Changes



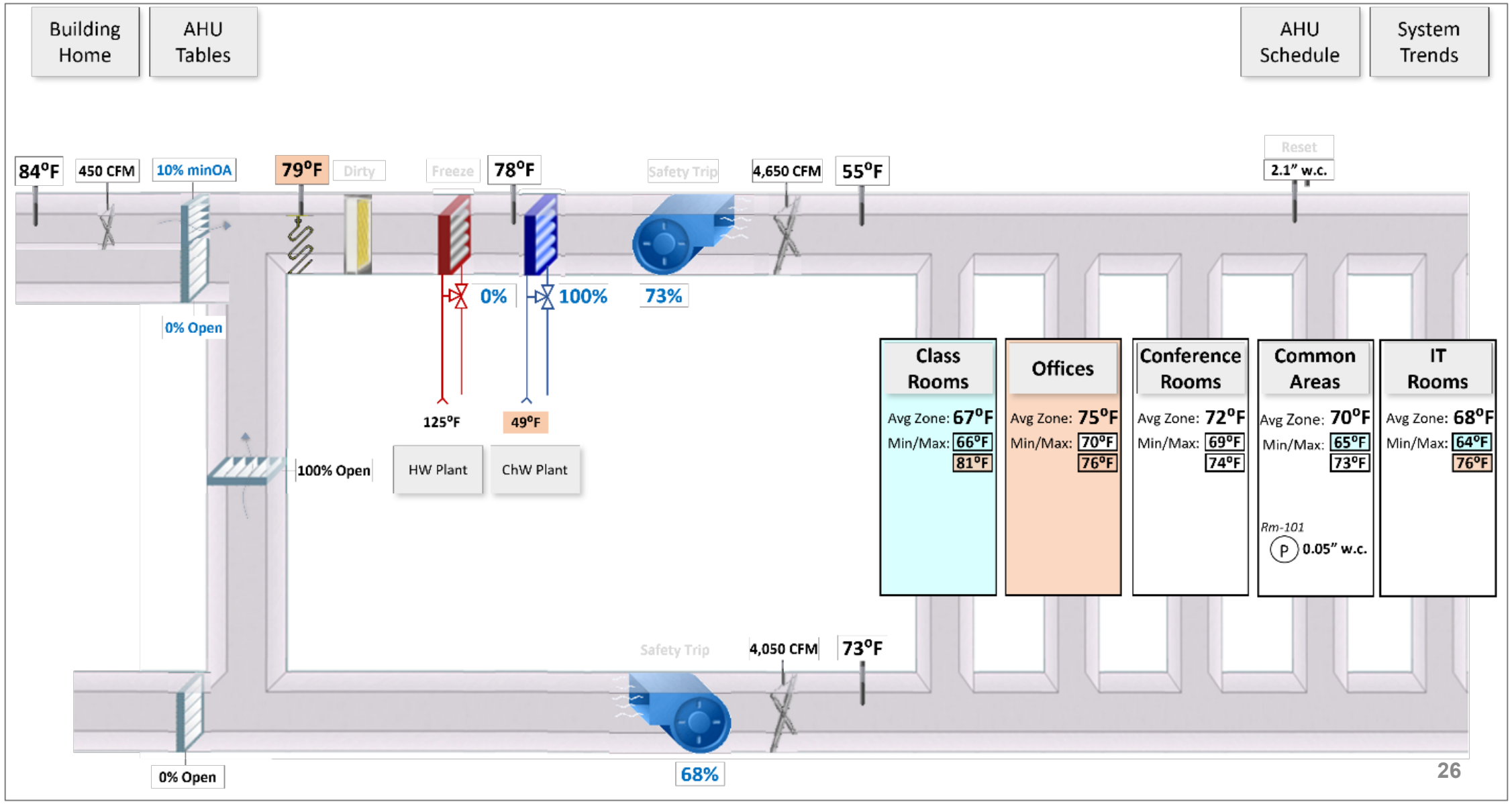
Use Same Coil Valve and Source Approach as Zone Graphics



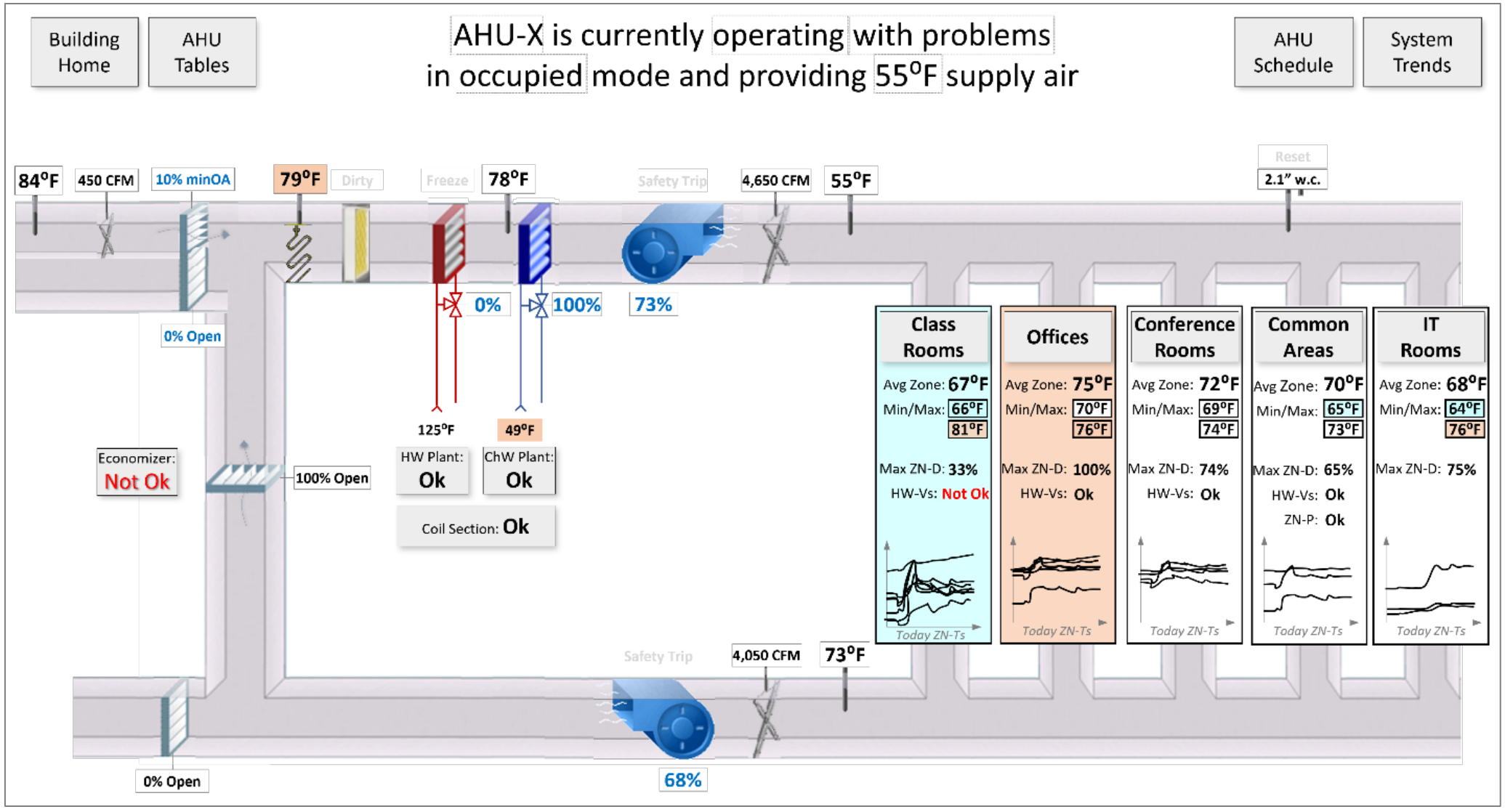
Key Revisions: Restructured and Reoriented



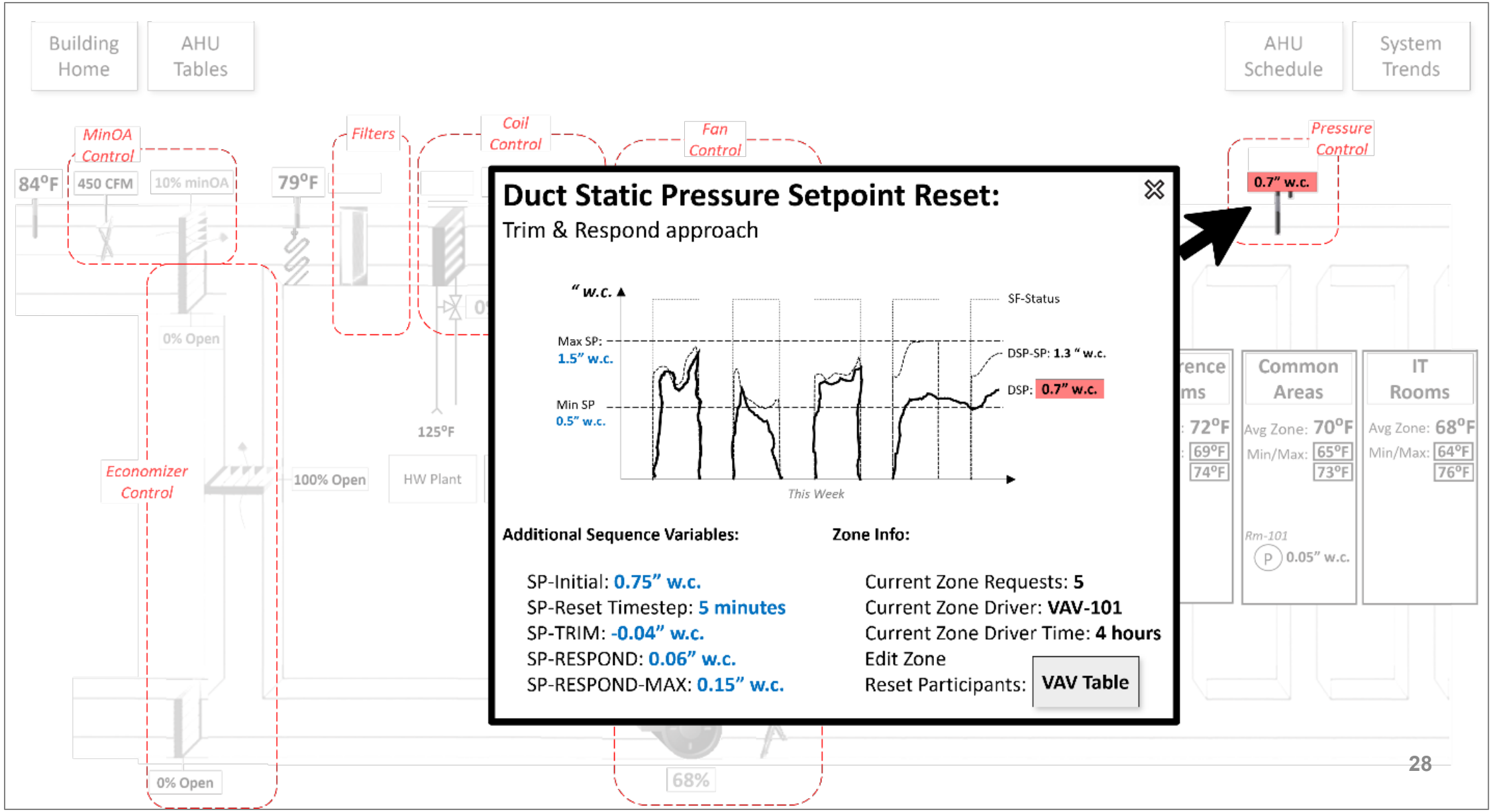
Additional Revisions: Formatted, Layered, and Linked



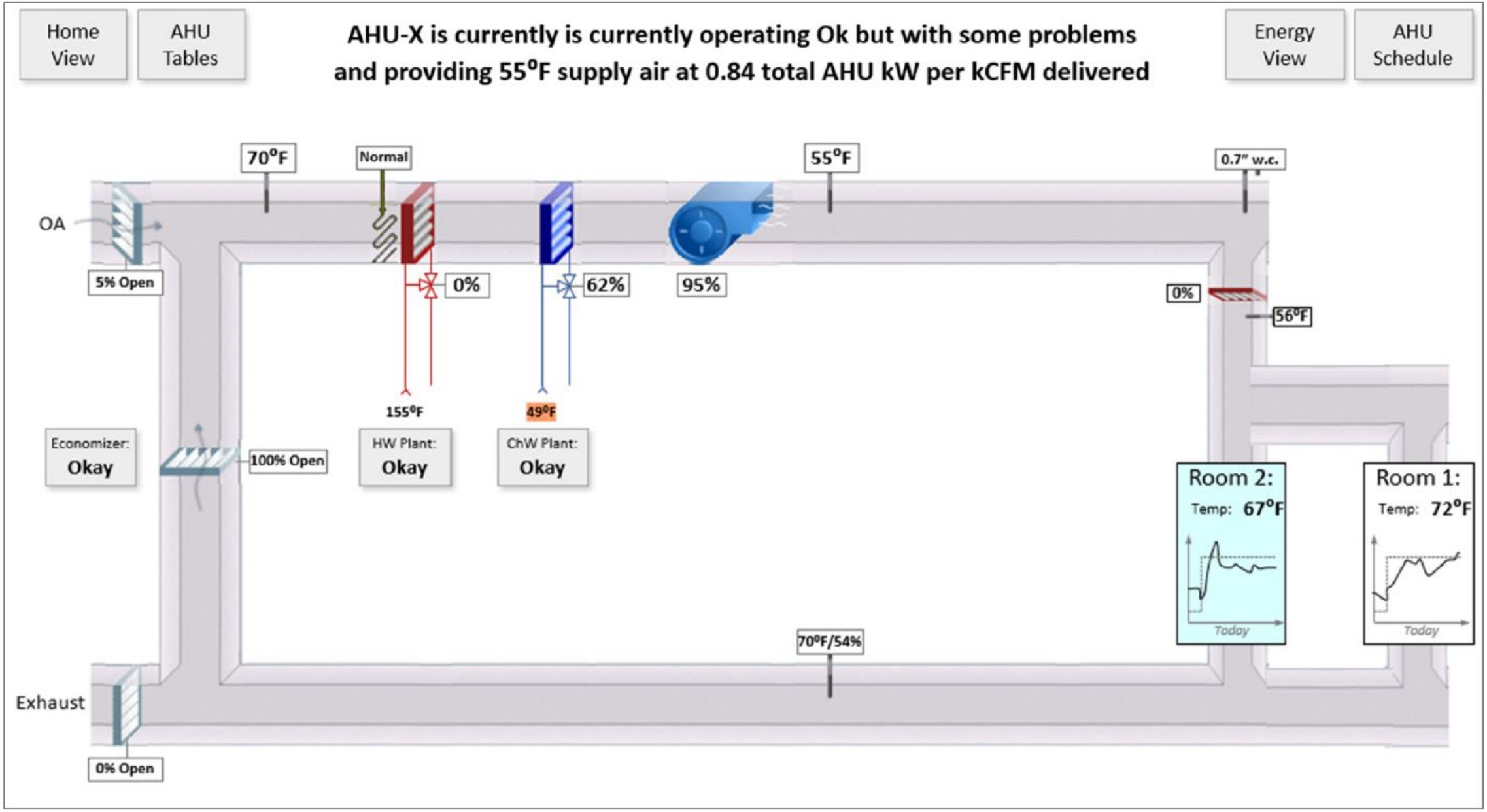
Final Revisions: Value-driven Insights



Final Revisions: Value-Driven Insights



This Approach Scales Well



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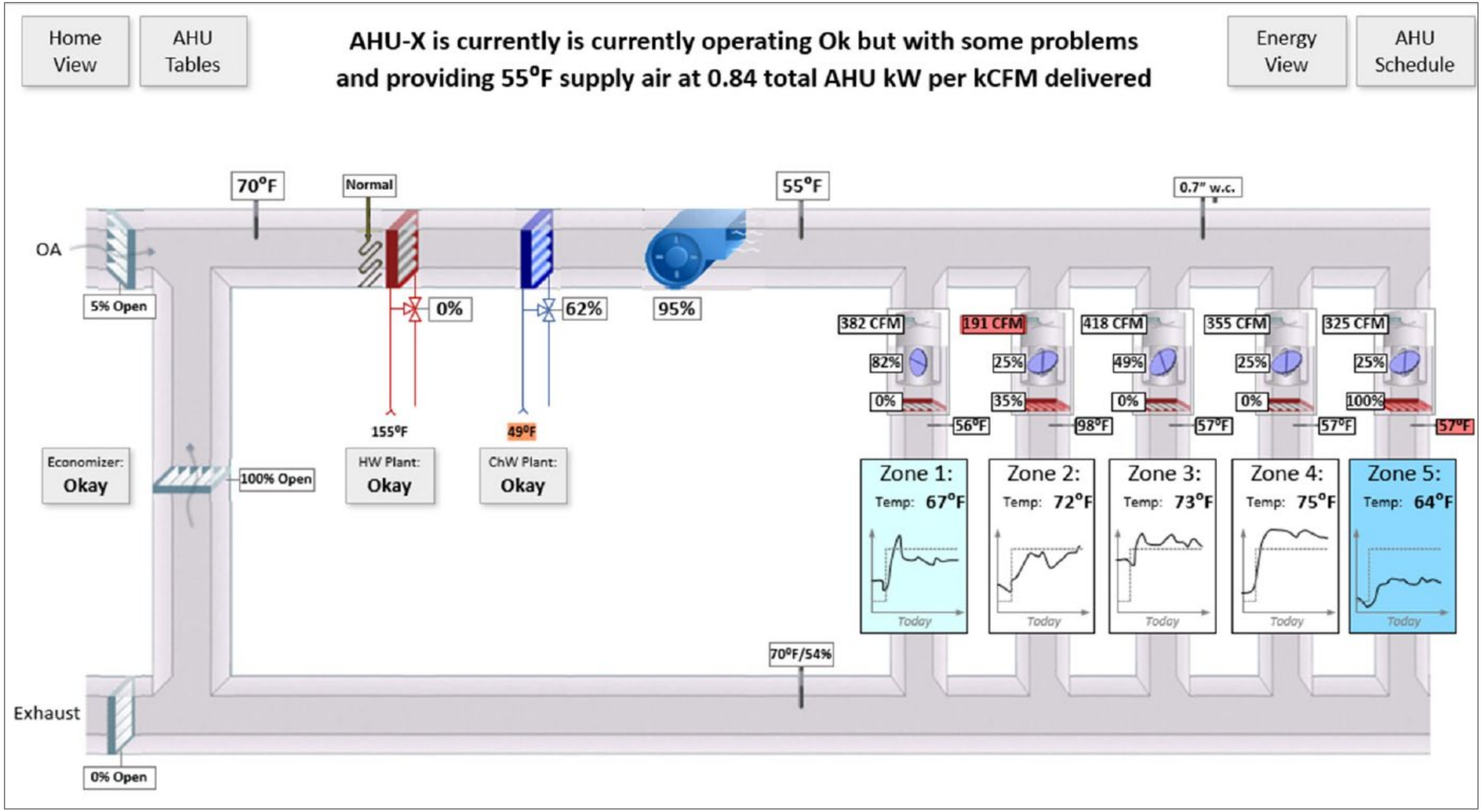

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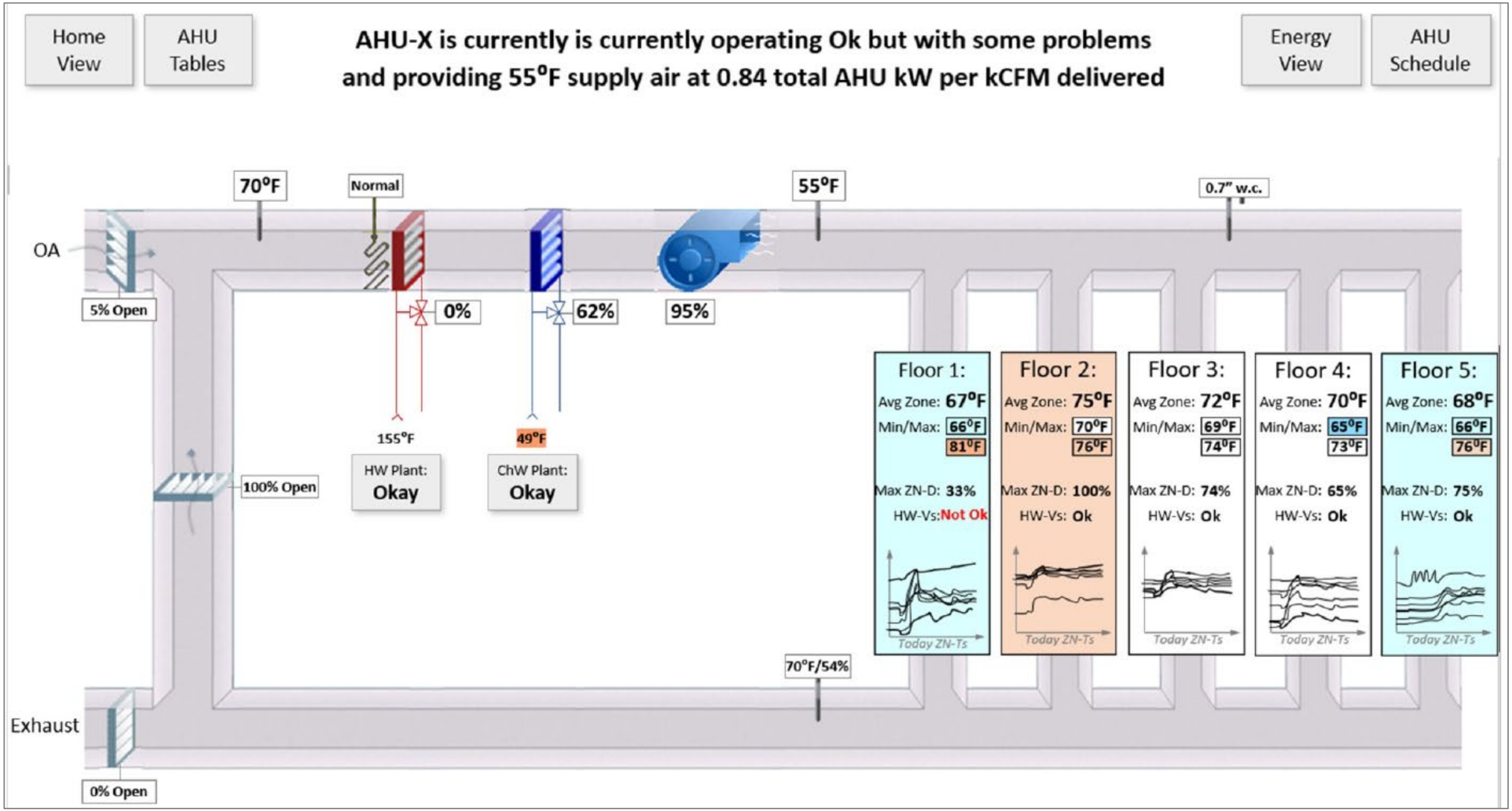

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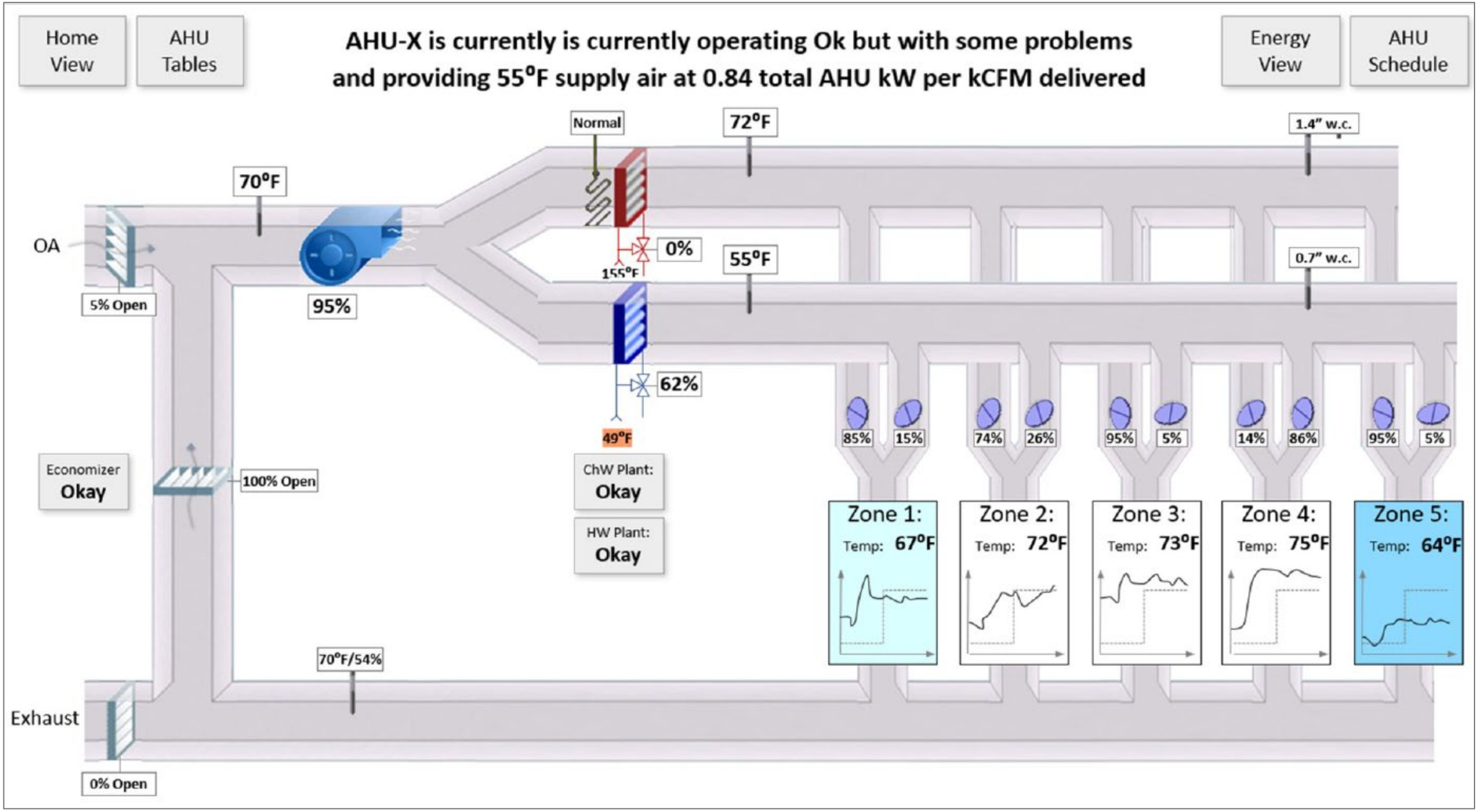

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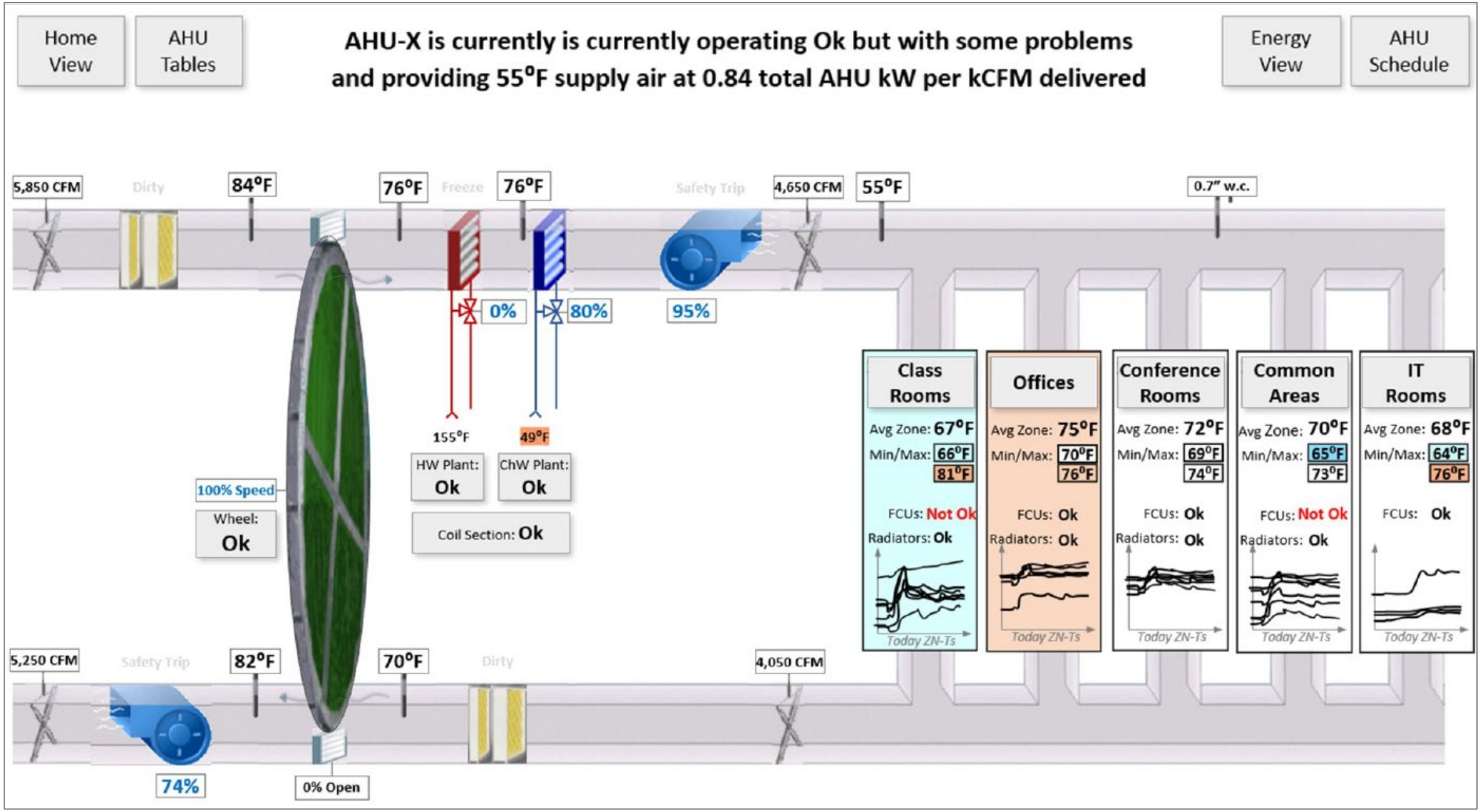
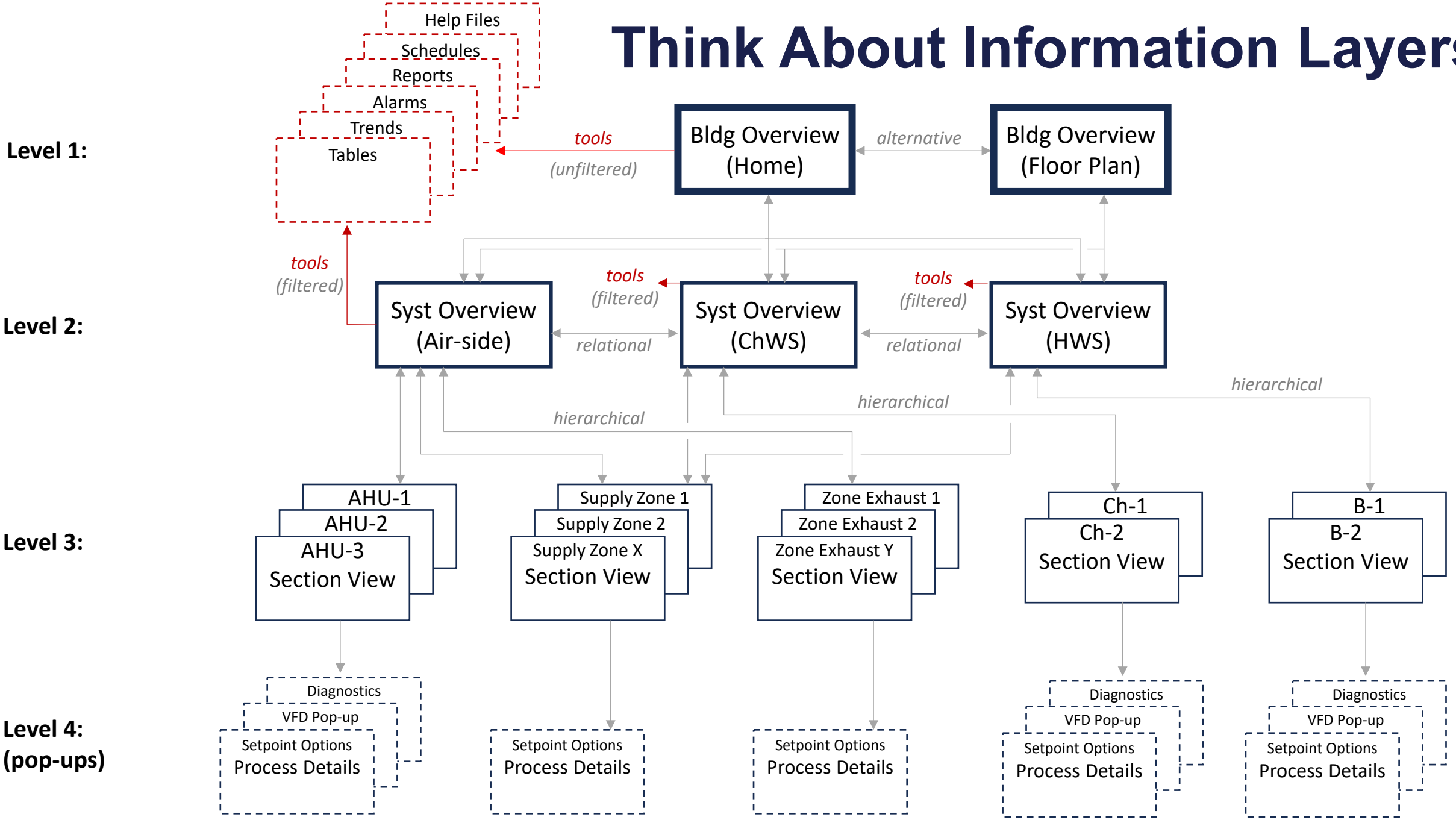


Think About Information Layers



Please Email our Team For Resources

Brian.c.clark@usace.army.mil

Robert.d.renz@usace.army.mil

- Report on Building Graphics Design Criteria
- Fault Detection & Diagnostics Report and RFP Template
- Installation Design Guide for Building Graphics
- Free Training on Building Controls Features
- Unified Facility Criteria Point Naming Conventions
- Whole Building Design Guide HVAC & UMCS Summary
- Point Schedule Templates
- Piloting New Building Graphics with Research Funds

Fault Detection & Diagnostics (FDD)

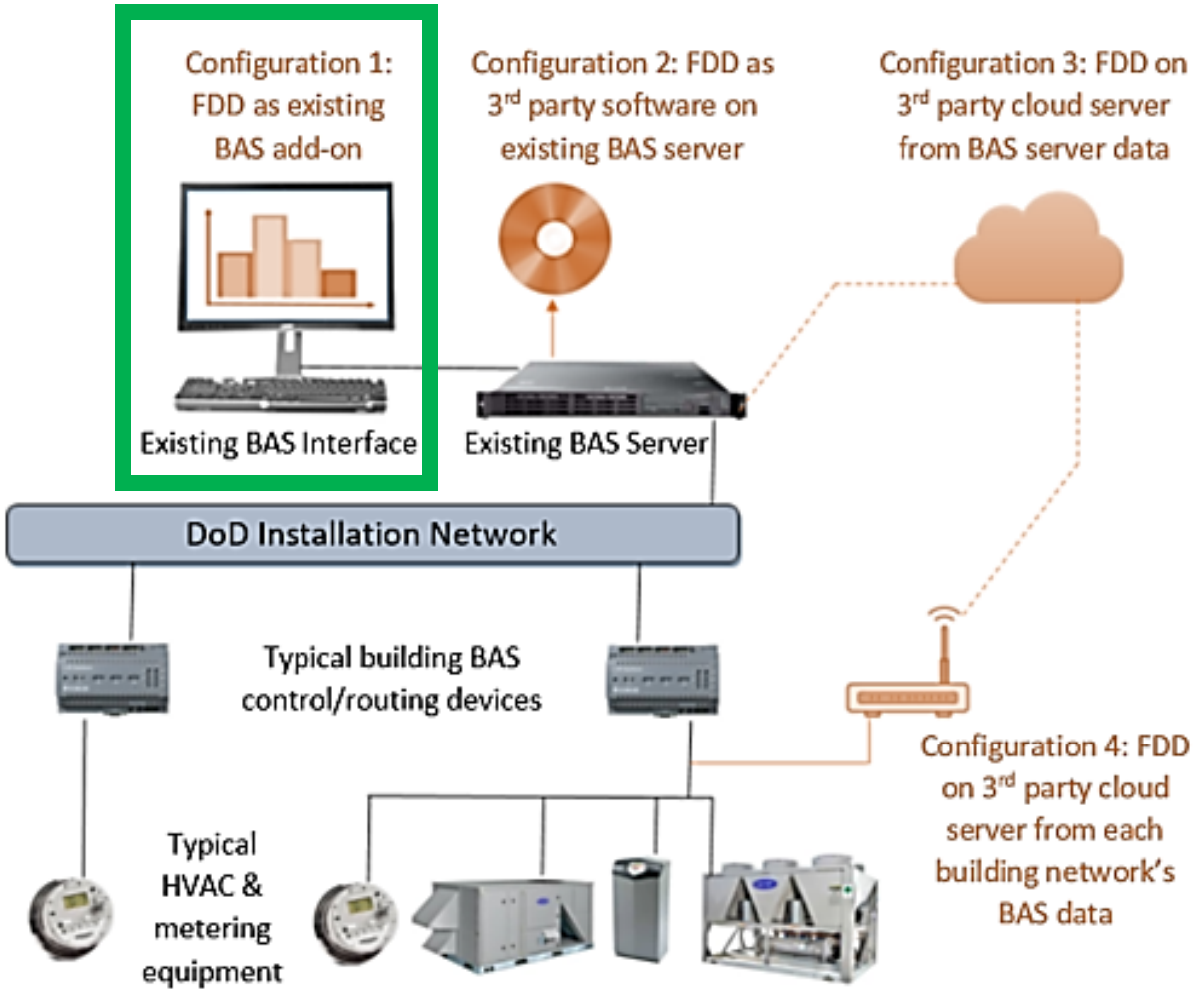
Functionality: What does FDD do?

- FDD software processes UMCS data to generate more detailed information on the source of and the solution to common performance issues
- FDD technologies (AKA data analytics or monitoring-based commissioning) are software programs that use customized algorithms, reporting, and dashboard graphics to provide prioritized action-oriented O&M info
- State-of-the-art FDD can use thousands of algorithms to calculate improved setpoints, diagnose errors, or automatically adjust operations

Configurations: What does FDD look like?

- FDD programs continuously run in local or enterprise configurations and offer enhanced early notification of failed, failing, or underperforming bldg systems
- Configurations can be distinguished by how FDD systems connect to existing UMCS networks (AKA BAS) and where the FDD software is located. Each configuration has implications on ease of implementation, on-going support costs, and cybersecurity compliance

FDD Configurations, Where Can FDD Live?



FDD Capabilities in Existing UMCS

Existing M&C software can execute certain aspects of FDD software already, that is not being enforced and rarely utilized:

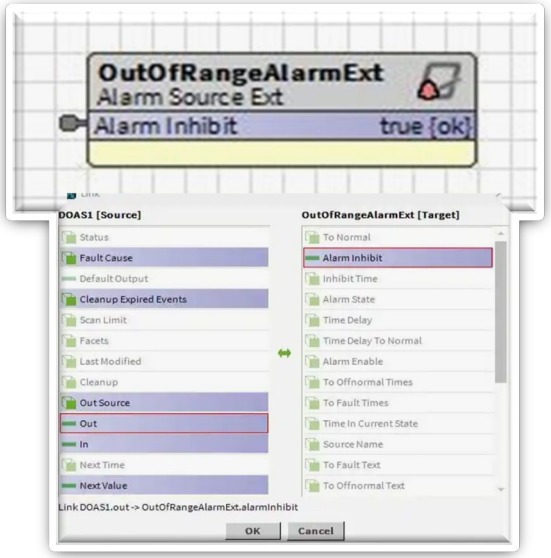
Attribute	Value
Metrics	
Point Scan Time	50 seconds
Transmits Per Minute	4264
Count	13530
Priority 1 Poll Items	4
Priority 2 Poll Items	60
Priority 3 Poll Items	6720
Priority 1 Poll Time	605 ms
Priority 2 Poll Time	14549 ms
Priority 3 Poll Time	50771 ms

Set alarm priorities-level 1, 2, 3 etc. and thresholds (Johnson Controls Metasys)

<u>Example Standard FDD Faults</u>

- Setpoint deviation detected
- Duct static pressure low at full fan speed
- Mixed air temps indicates economizer failure
- Prolonged unscheduled equipment operation
- Energy usage above monthly or annual baseline
- Simultaneous heating and cooling identified
- HVAC valve or damper output signal cycling
- Temperature sensor fail or calibration
- Control loop enable issues
- Boiler or Chiller short cycling

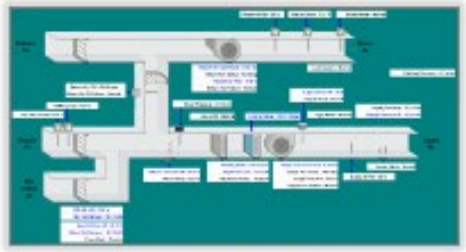
FDD-Lite



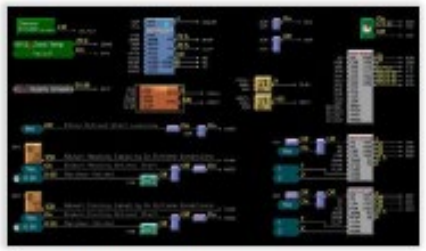
Hierarchical alarm suppression to reduce nuisance alarms (Niagara alarm inhibit)

FDD- Standardize Functionality, Deliverables, and Artifact

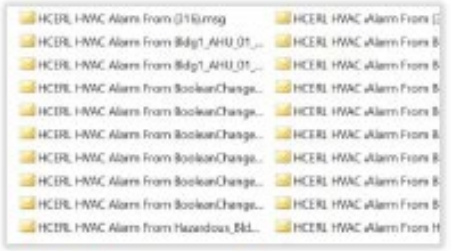
This is typically how we look for problems in our buildings



Watch graphics like these…

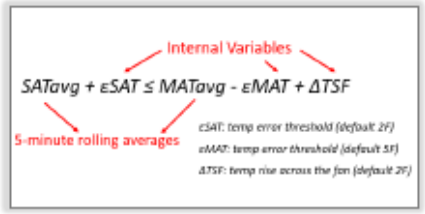


Sift through tons of logic…



Wait for alarms that make sense…

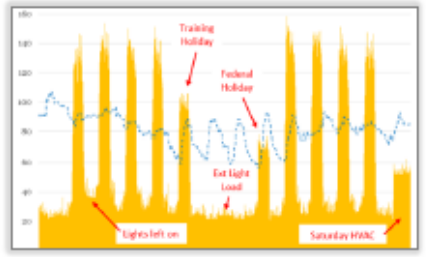
This is how industry uses FDD to save 9% in energy per year at a 2 year payback



Advanced fault algorithms

Priority	Fault Description	Fault Effect	Corrective Action
#1	Fan equipment schedule has been overridden to 24/7	$4,800/year in energy costs; $800 in O&M	Reschedule unit, extend warm-up time to 2 hours
#2	Supply temps are set too low causing reheat use	$2,200/year in extra heating, pumping, and cooling costs	Implement load-based supply temp reset sequence
#3	Room 101 reheat valve has failed open	$240/year in gas costs; non-critical comfort issue	2nd fault: order 1.5" 2-way valve, Cv 0.8 ($160)

Prioritized and descriptive faults



Interactive visuals

More usable interfaces

This Makes Room for True KPIs

Key Performance Indicator			Scale				Aggregation Function			
Type	Name	Description	Portfolio	Building	System	Equipment or Zone	Count	Peak	Average	Sum
Functional	Run Hours	operational runtime		x	x	x			x	x
	Equipment Fail-Hours	hours with recorded valve, damper, or other equipment failure	x	x	x	x			x	x
	Start-up Time	time it takes to achieve within 1°F of setpoint upon startup		x	x	x			x	
	Setpoint Deviation Degree-Hours	product of temperature deviation amount and number hours at that deviation		x	x				x	x
	Load Percentage	percent actual load divided by nominal or design load		x	x	x		x	x	
	Load Performance	kW/ton for chilled water, MBtuh/SF or efficiency for hot water, kW/SF for lighting,			x	x		x	x	x
	Airflow Performance	total fan and coil energy per kCFM of supply air		x	x			x	x	x
	Percent Airflow Error	percent of airflow setpoint deviation		x	x				x	x
	Economizer Performance	amount mixed air deviation from ideal during operation times the amount of time deviated		x	x	x			x	x
	Delta T-Hours	product of chilled water system delta T and total operational time			x				x	x
	Percent Reset	percent of operating time in a setpoint reset mode			x				x	x
	Actuator Percentage	valve or damper percent open command				x		x	x	
	Sensor Health Score	percent of sensors within range signals		x	x	x			x	x
	Controller Health Score	percent of controllers showing front-end connection	x	x	x				x	x
	O&M Health Score	annual work order count divided by Current Replacement Value (K)	x	x	x		x	x	x	x
	HVAC Complexity	number of HVAC pumps		x	x		x			

This Makes Room for True KPIs

Key Performance Indicator			Scale				Aggregation Function			
Type	Name	Description	Portfolio	Building	System	Equipment or Zone	Count	Peak	Average	Sum
Financial	Facility Performance Index	total annual energy costs divided by Current Replacement Value	x						x	x
	Ventilation Cost Rate	total fan and plant load energy cost associated with minOA amount / minimum air CFM		x	x				x	x
	Load Shift Savings	amount of kW costs shifted by thermal storage	x	x	x				x	x
Environmental	Complaint Score	number of hot/cold work orders divided by design occupant count	x	x			x			x
	Indoor CO2	Zone or return air CO2 value		x	x	x		x	x	x
	Occupied Zone Temperature	zone temps recorded during occupied mode		x	x	x		x	x	x
	Peak Weather Hours	time registering outside of given design conditions	x	x				x		x
	Carbon Footprint	Source CO2 in tons from combined energy meter readings	x	x	x				x	x
Energy	Power Use Effectiveness	total IT area energy divided by IT equipment only energy			x			x	x	x
	Benchmark Deviation	percent deviation from annual peer-group benchmark index		x					x	x
	Baseline Deviation	percent deviation from prior years' baseline index		x					x	x
	Normalized Energy Use	annual energy use divided by runtime hours x HDD or CDD		x					x	x

Questions?

U.S. DEPARTMENT of ENERGY | Federal Energy Management Program

FEMP Summer Workshops

This Training Is Accredited

How to obtain your CEUs:

1. Log in to https://edu.wbdg.org/ using your WBDG credentials
   - The assessment and evaluation will be made available to attendees at 8:00am ET on Monday, August 11th
   - The assessment and evaluation will close on September 22nd
2. In the list of trainings you attended, click on the Visit link by the course you wish to complete
   - If the course you're looking for is not listed, click on My Account in the top right menu
   - If you still can't find your course, contact the WBDG support team to check your eligibility
3. Complete the assessment with a score of 80% or above
4. Upon passing the assessment, click the Post-Evaluation Survey button
5. Complete and submit the evaluation
6. Click Download Your Certificate to generate your certificate of completion, which can be downloaded for your records

Questions or issues? Contact WBDG Support at wbdg@nibs.org.

What's an IACET CEU?

A continuing education unit (CEU) from the International Association for Continuing Education and Training (IACET) equals 10 hours of learning in an approved program for licensed or certified professionals.

Thank You

U.S. DEPARTMENT of ENERGY | Federal Energy Management Program

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