10+ HVAC Troubleshooting Tips for Healthcare Facilities

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2019 WHEA Webinar

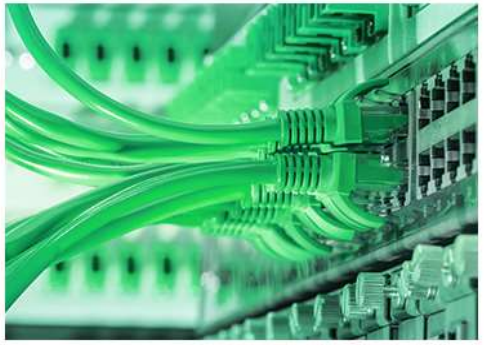
Johnson Controls

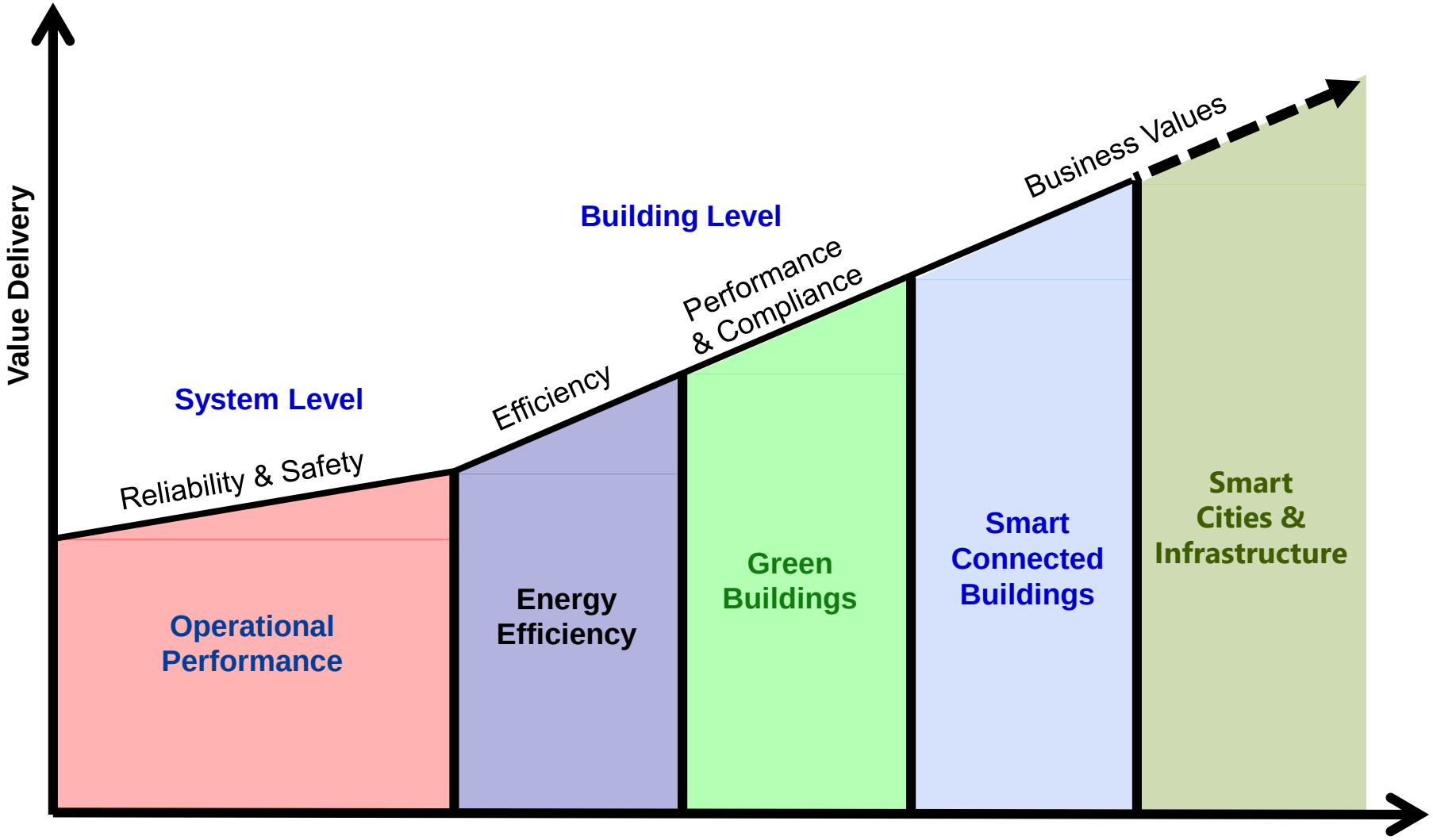
Johnson Controls Institute Overview

- Operation & Maintenance (O&M) Learning since 1947
- Facility O&M Strategies and KPI Best Practices
- Facility, Workforce, and Equipment Assessments
- Custom Onsite Career Development Programs
- Virtual Field Trips, Webinars, and Self-Study Learning
- Discover New O&M Tips, Tools, and Cheat Sheets
- Practice on Simulators and Onsite Field Equipment
- Experienced and Certified Instructors & Consultants
- Thousands of Customers & Partners each Year
- www.johnsoncontrols.com/institute

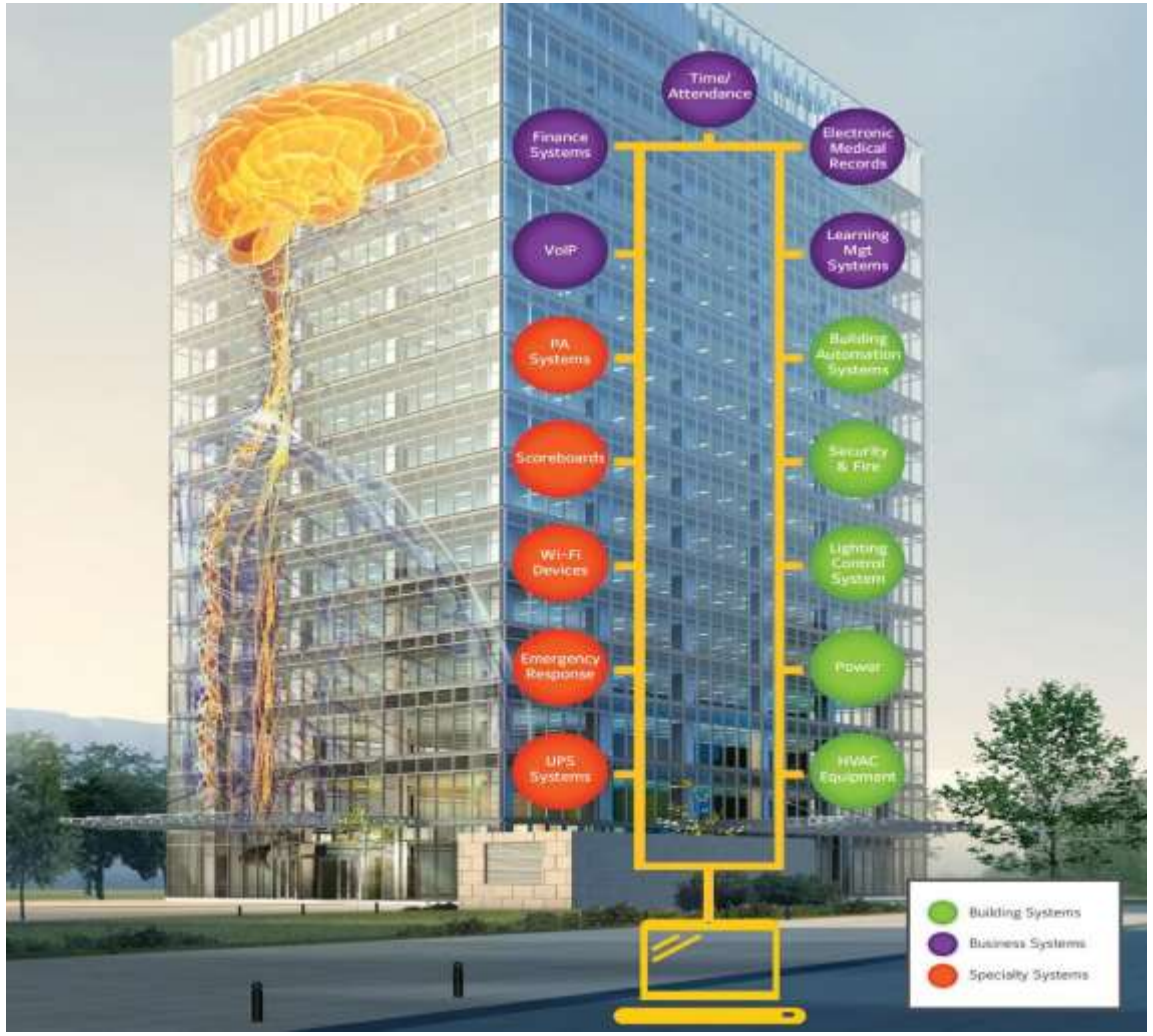

EXIT

Evolution of the building industry



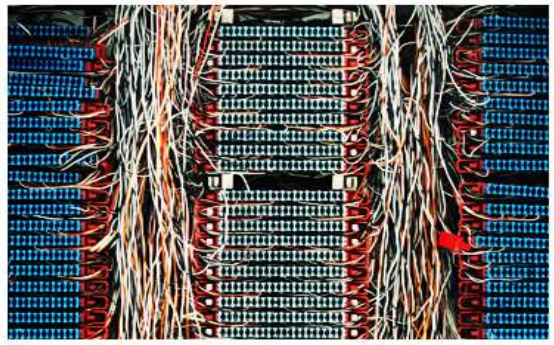


Buildings are complex to maintain



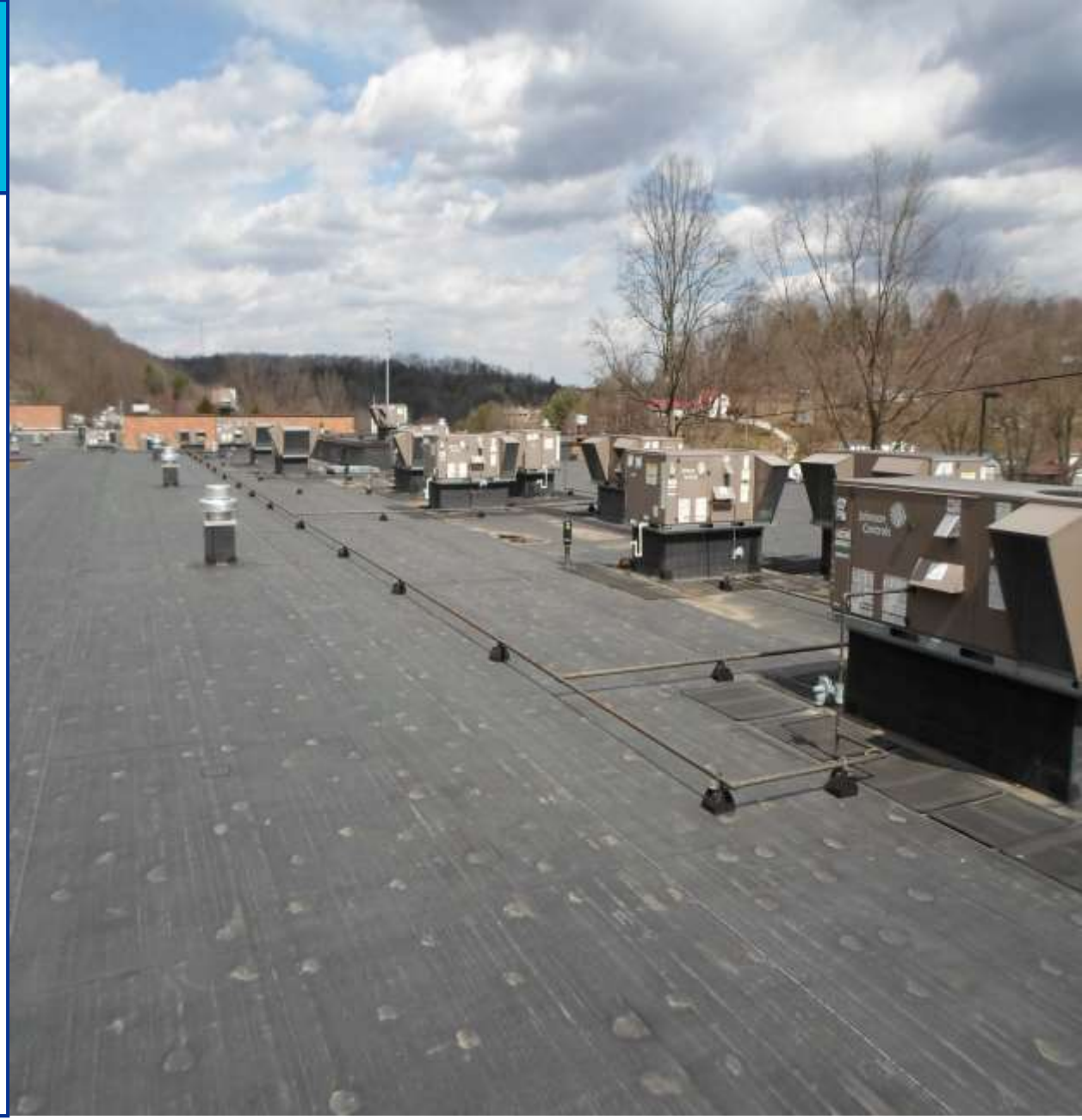
- Lifespan of **40+** years outlives most systems
- Mix of systems, suppliers and protocols
- Dynamic ecosystems
- Changing regulations and building codes over time

Building managers have to balance many demands



Common Healthcare Challenges

- Workforce Skill Gaps & Productivity
- Workforce Engagement & Turnover
- Equipment Life and Reliability Issues
- Facility Operation & Management Risks
- Facility Energy Reduction Targets
- Joint Commission Compliance Issues
- Patient, Family, and Staff HVAC Satisfaction
- Staff can’t keep up with O&M work orders
- Maintenance Team(s) Communication Gaps



Facility O&M Workforce Assessment & Development Tools

- HVAC & Equipment Technicians
- Control & Automation Technicians
- Control & Automation Engineers
- Work Management & Facility Analysts
- Utility Plant & Boiler Operators
- Facility Operators & Facility Controllers
- Electricians & Telecommunication Techs
- Steamfitters & Sheet Metal Workers
- Pipefitters & Stationary Engineers
- General Trades Workers & Custodians
- Plumbers & Refrigeration Mechanics
- Carpenters, Locksmiths, & Painters
- Building Engineers & Facility Engineers
- Operation & Maintenance Specialists
- Safety Coordinators & Fire Technicians
- Security System Technicians
- Administrators & Service Coordinators
- CMMS System Administrators
- Operation & Maintenance Supervisors
- Facility Managers & Directors

Facility O&M Workforce Assessments and Development Solutions

With Facility Operation & Maintenance (O&M) budgets continuing to shrink, why waste limited training dollars on courses your workforce may not need? The Johnson Controls Institute can maximize your training investments by assessing your Facility O&M Staff Skills and working with your teams to identify the best development solutions to meet your facility performance goals.

The JC Institute has over 60 years of success developing people to operate and maintain buildings. We assist large and small workforces in hospitals, education facilities, pharmaceutical companies, office buildings, utility companies, and government facilities. Our services are customized for your needs and typically include the steps below:

STEP 1: Review Facility Strategies and Desired Outcomes

STEP 2: Complete Site-specific Skill Assessments by Job Roles

STEP 3: Analyze Root Causes of Staff Performance Gaps

STEP 4: Design and Deploy Solutions and Development Maps

STEP 5: Assess Outcomes and Track Results on Scorecards

Sample Workforce Assessment Analysis (STEP 3)

Our Workforce Assessments provide concrete data to make sound employee development decisions to maximize budget dollars for the greatest impact on your facility portfolio. The following graphic shows the type of assessment detail available.

Sample Skills Assessment Gap Chart

Level 1 identifies core skills that most employees should have as a minimum.

This column shows the average performance gap for entire HVAC technician team. A Zero Score = Expert Skills Score of 100 = 100% Skill Gap

This employee is an expert at reading schematic drawings.

Sample HVAC Technician Gap Analysis Training Report

HVAC Technicians Core Tasks	Average Team Gap (%)	HVAC Tech 1	HVAC Tech 2	HVAC Tech 3	HVAC Tech 4
Task Level 1 Average L1 Gap (%):	**16.7**	**17**	**20**	**27**	**20**
Category: Planning and Organization	26.0	37	31	37	25
Category: Communications	20.0	20	0	60	20
Category: Managing Customer Expectations	9.6	0	12	24	12
Category: Basic Computer Skills	10.0	0	25	0	25
Category: Safety & Accident Prevention	10.8	18	0	36	0
Category: General Mechanical Systems Maintenance	0.0	0	0	0	0
Category: Facility Systems Troubleshooting	12.0	0	40	20	0
Category: Electricity for Building Services	8.0	10	20	0	10
Category: Reading Schematic Wiring Diagrams	8.0	0	20	0	20
Category: HVAC Electronic Controls	26.0	30	10	50	40
Category: Reading Jobsite Drawings	15.0	0	25	25	25
Category: Facility Management Systems and Digital Controls	45.4	36	55	100	36
Category: Refrigeration Certifications & Skills	12.0	20	0	40	0
Category: Air Handling Units w/HW & CW Coils	0.0	0	0	0	0
Category: Air Compressors	0.0	0	0	0	0
Category: Air Dryer	55.0	0	100	75	100
Category: Fan Coil Units	0.0	0	0	0	0
Category: Rooftop Air Handling Units	0.0	0	0	0	0
Category: Centrifugal Chillers	65.0	100	75	100	50
Category: Chilled Water Pumps	46.8	33	67	67	67
Category: Low Pressure Hot Water Boilers	0.0	0	0	0	0
Category: DI and RO Water Pumps	10.0	20	0	10	20
Category: Diesel Fuel Pumps	0.0	0	0	0	0
Category: Cooling Towers	44.0	60	20	80	40
Category: Exhaust Fans	0.0	0	0	0	0
Category: Variable Frequency Drives	65.0	100	50	100	75
Category: Walk-in and Reach-in Freezers	0.0	0	0	0	0
Category: Liebert DX Computer Room Units	16.0	20	40	0	20
Task Level 2 Average L2 Gap (%):	**48.0**	**18**	**62**	**81**	**80**
Category: General Mechanical Systems Maintenance	40.0	25	50	75	50
Category: Facility Systems Troubleshooting	60.0	0	100	100	100
Category: Electricity for Building Services	40.0	30	70	40	60
Category: Facility Management Systems and Digital Controls	65.0	33	89	89	89
Task Level 3 Average L3 Gap %:	**71.4**	**57**	**100**	**100**	**100**
Category: Facility Management Systems and Digital Controls	71.4	57	100	100	100

Level 2 skills are more complex so the gaps are usually larger.

Level 3 skills are highly complex so you may only need a few specialists.

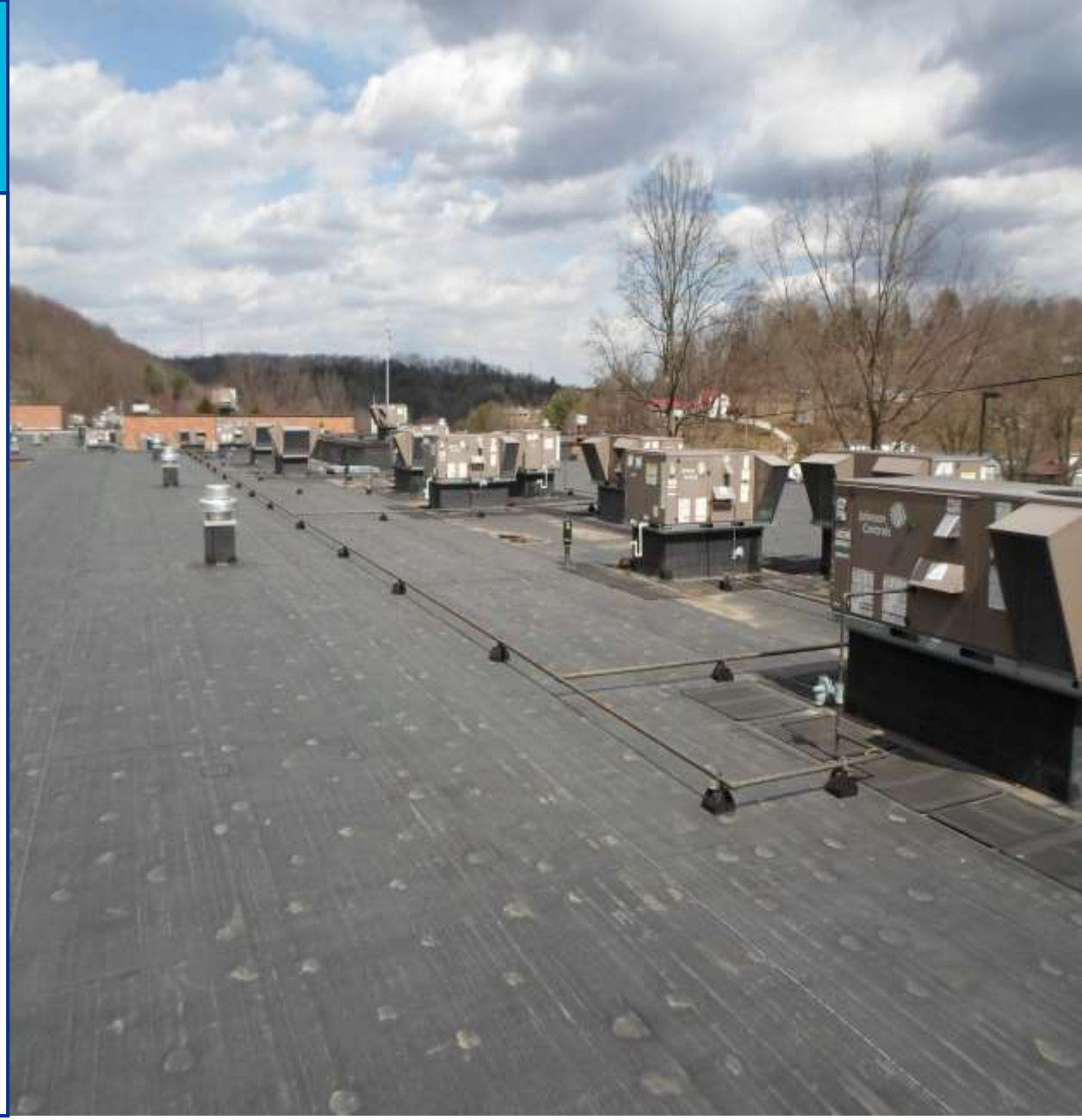
Areas in red indicate major staff performance gaps.

This employee has no skills regarding variable frequency drives.

Our clients use this report not only to determine specific development needs but also to determine which employee is best suited to respond to specific work orders. It becomes their Dispatch Resource Guide and Development Planning Guide.

Common Healthcare HVAC Problems

- Patient Room Hot/Cold calls – VAV Boxes?
- Too much equipment in ceilings to reach HVAC
- Critical Rooms - pressurization issues
- HVAC Pump, Motor, and Blower problems
- Valves not able to fully open and close
- Dampers not able to fully open and close
- Air handlers tripping off for multiple reasons
- Water leaks from various HVAC equipment
- Boilers tripping off for multiple reasons
- Pneumatic control leaks - some inside walls
- Multiple HVAC overrides in BAS controls
- HVAC contractors not commissioning their jobs




WARNING
Johnson Controls
YORK Solution XT
IMPORTANT
IMPORTANTE
Johnson Controls
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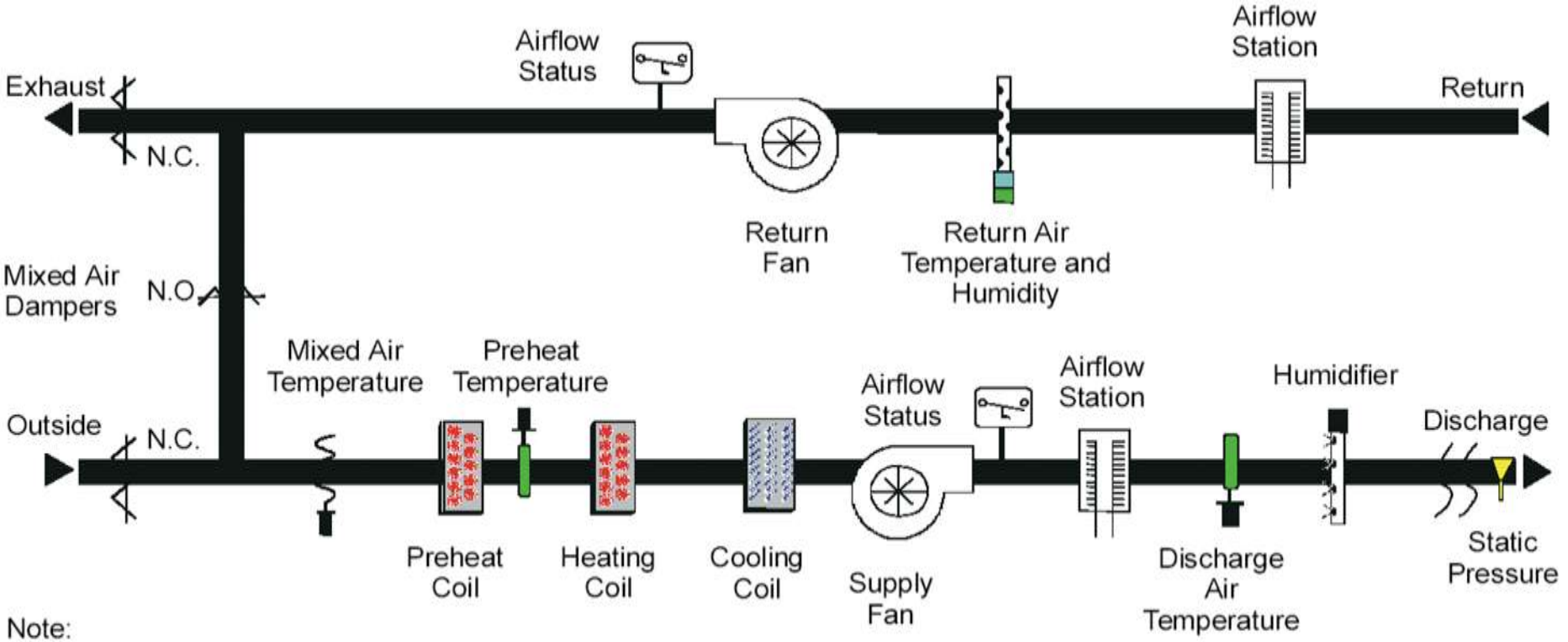
VFD
BYPASS
BYPASS
OFF
HAND
AUTO
VFD Input
Service Switch
Under Cover
CAUTION
VOLTAGE MAY BE PRESENT FROM MORE THAN ONE SOURCE AND SHOULD BE DISCONNECTED FOR SERVICING.
ATTENTION
Johnson Controls

Typical HVAC Control Strategies

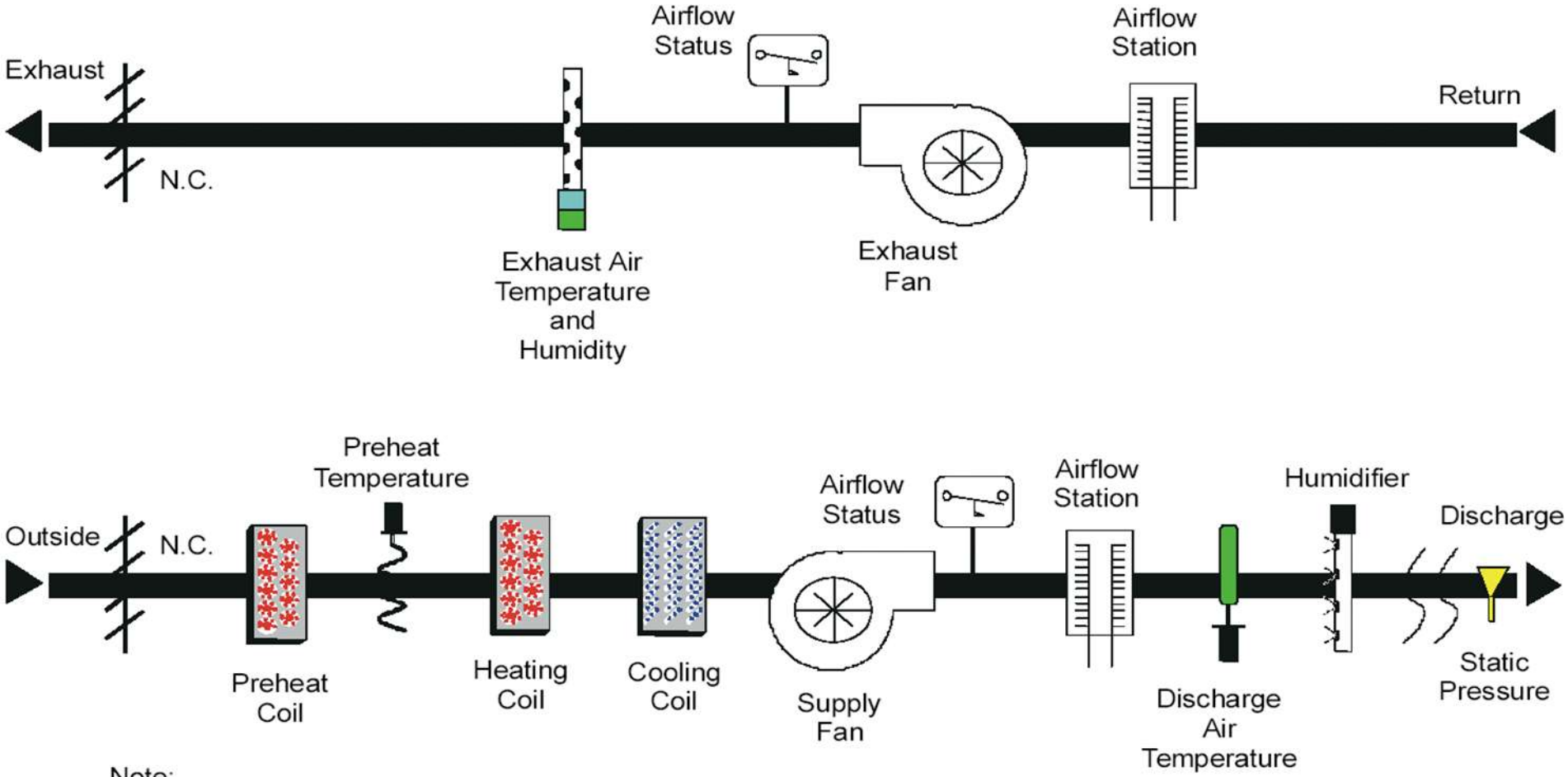
Mixed Air, Single Path



Note:
Coil arrangement may differ:
- Preheat coil may be in the outside air duct before the mixed air sensor.
- Heating coil may be after the cooling coil for dehumidification control.
- Heating and/or cooling coil may be after the supply fan.

MASPDUCT

100% Outside Air Single Path



Note:
Coil arrangement may differ:
- Heating coil may be after the cooling coil for dehumidification control.
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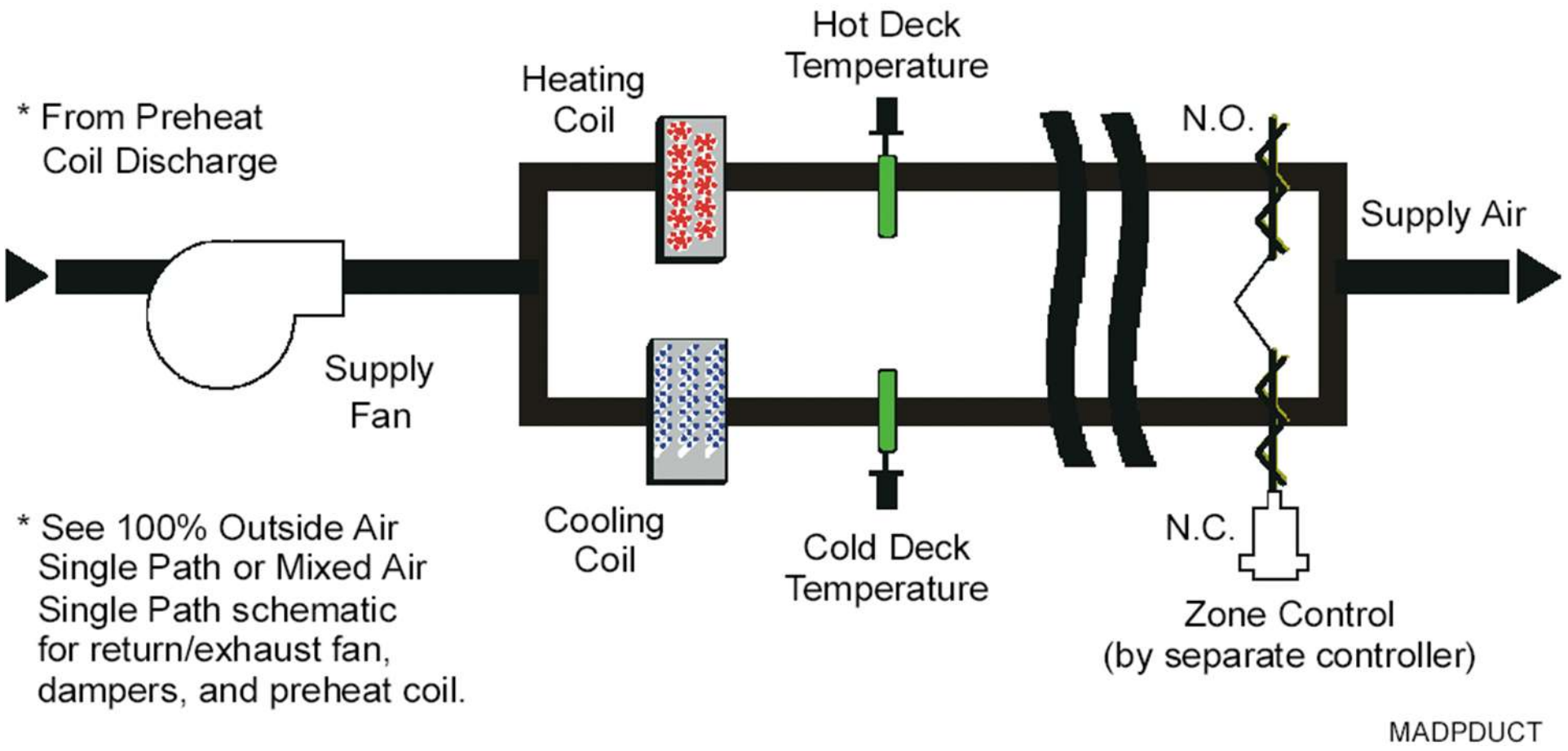
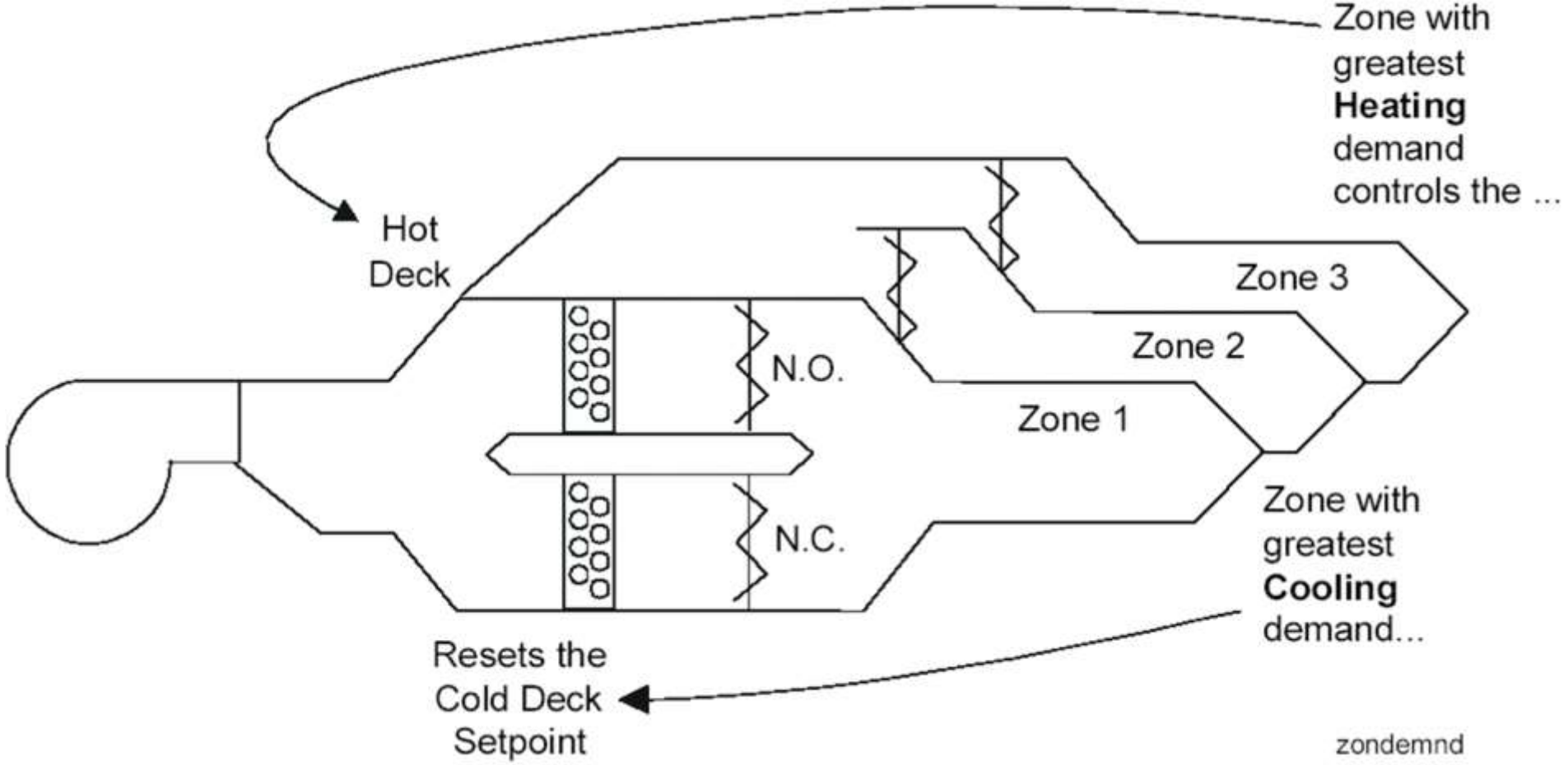
OASPDUCT

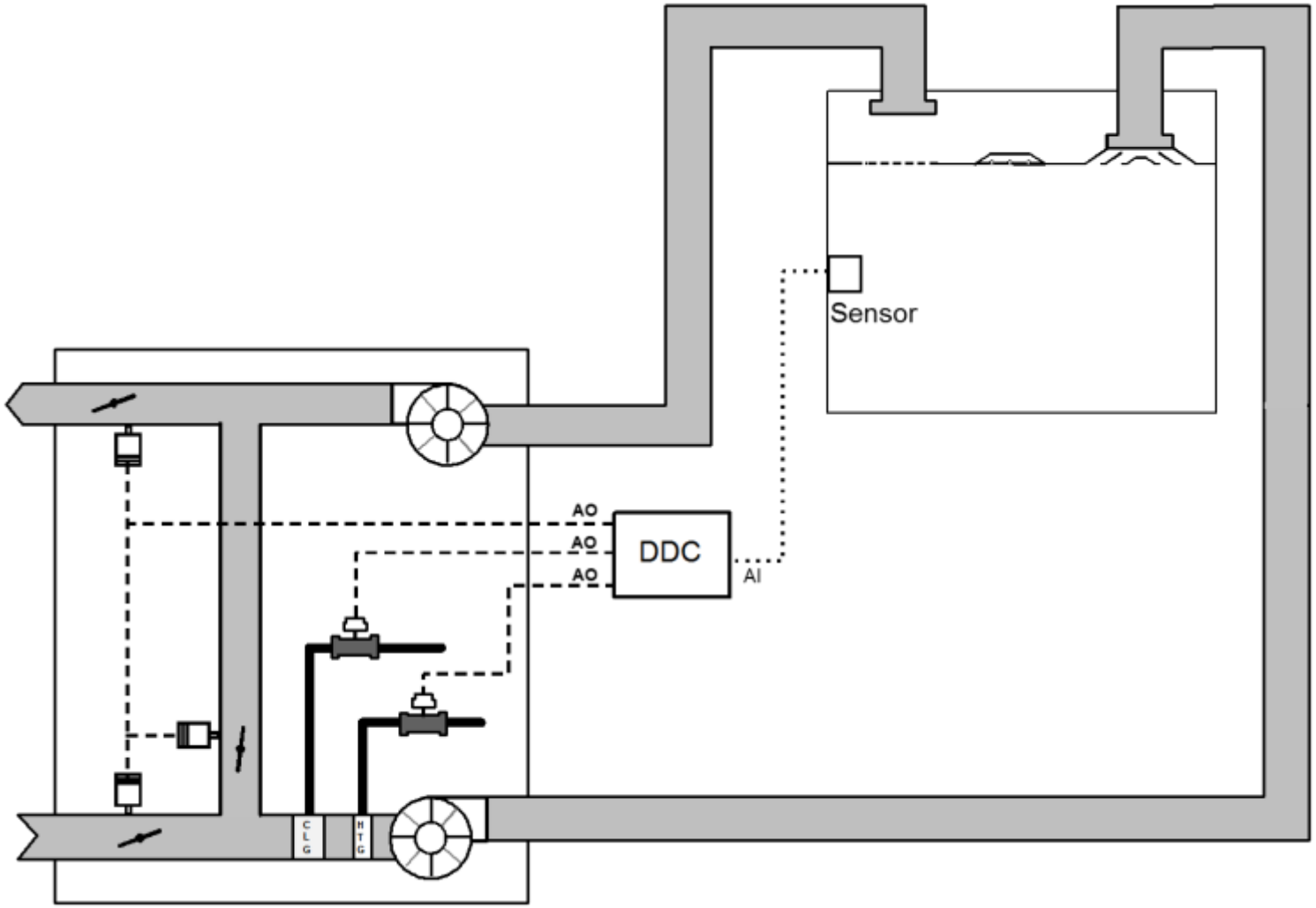
Dual Path Dual Duct (100% OA or MA)



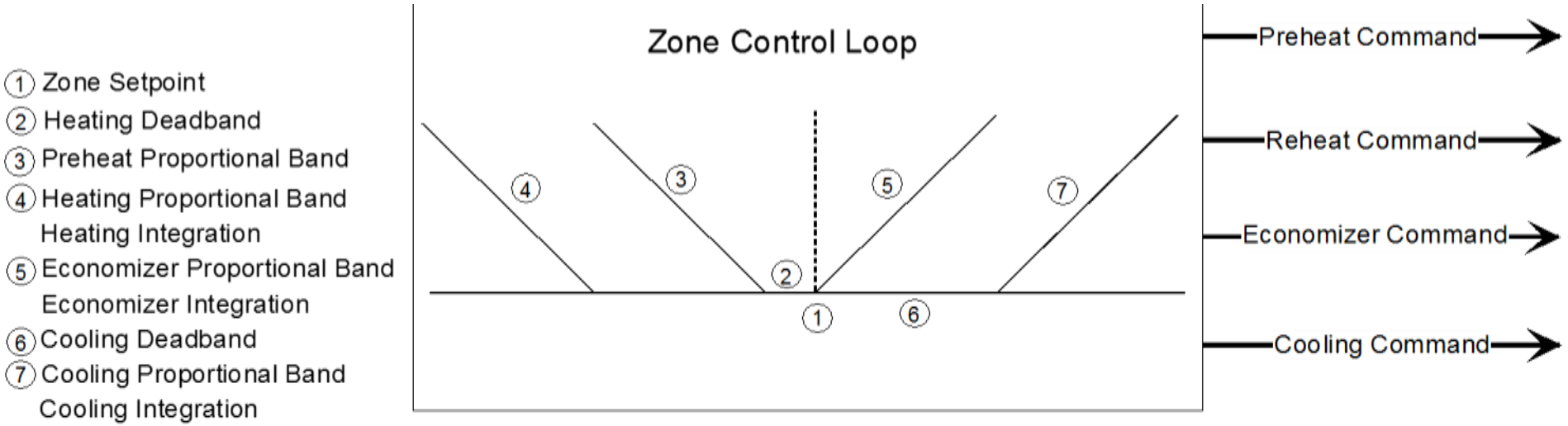
Dual Path Multi-Zone (100% OA or MA)



Room Control

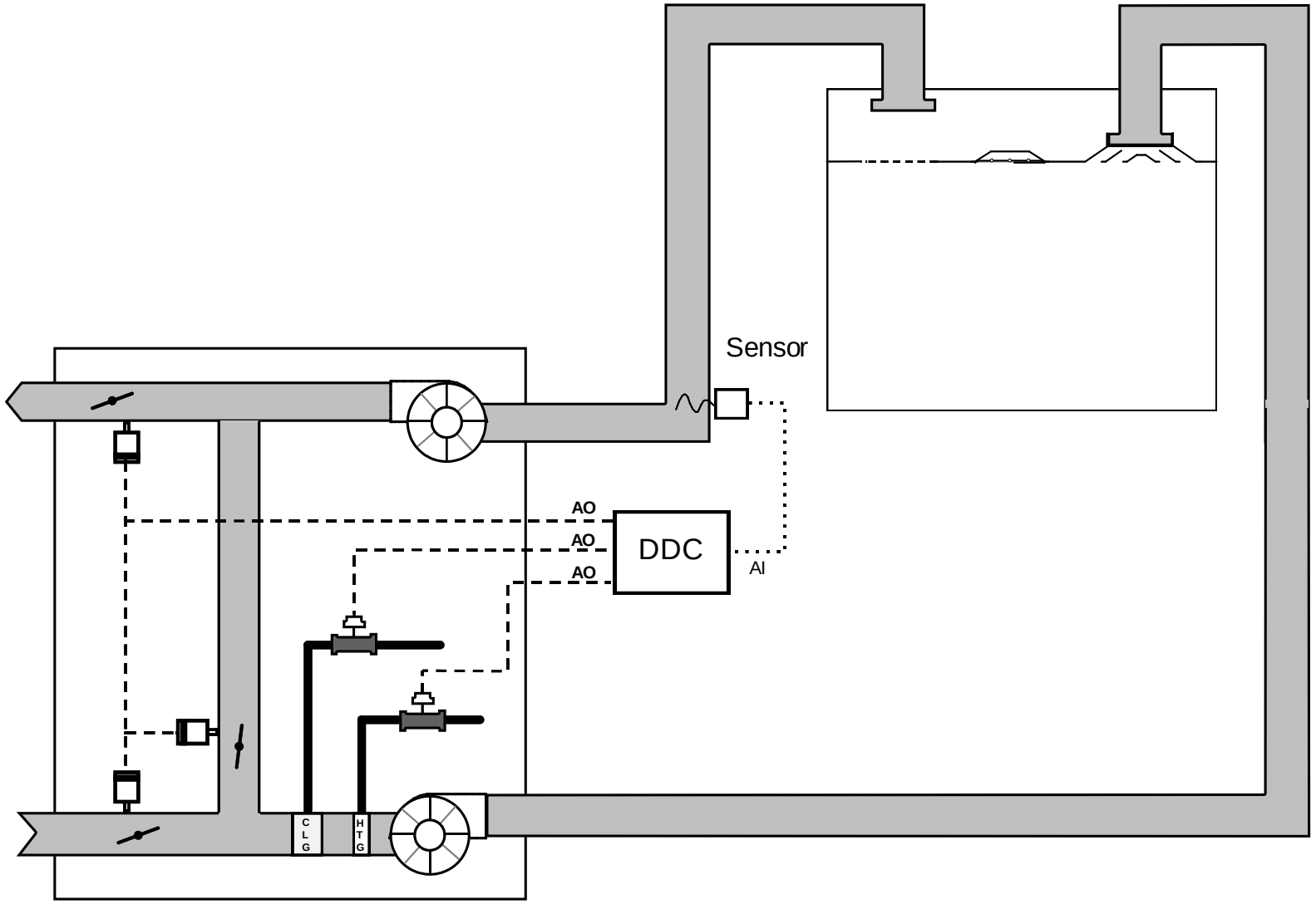


Room / Zone Control Loop



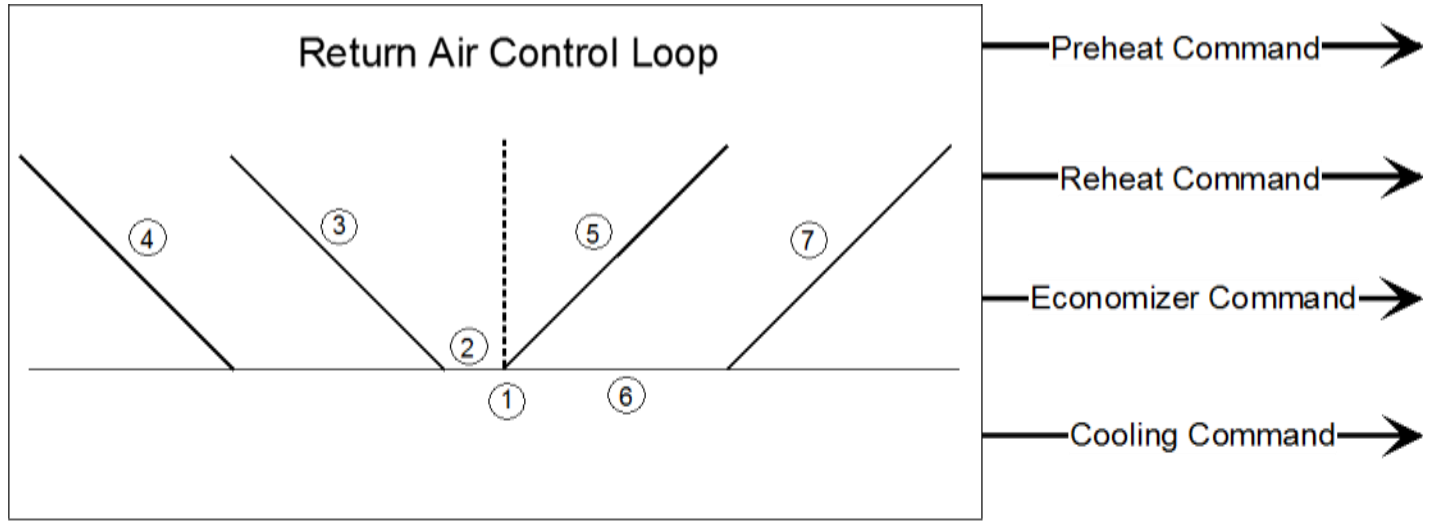
The Room Control strategy uses the zone temperature to directly control each controlled device. As the zone temperature decreases into the heating proportional band, the system commands the preheat (if selected and sequenced) and heating devices in sequence. As the zone temperature increases above the zone cooling setpoint, the system controls the outdoor air damper (if selected and sequenced) and mechanical cooling device in sequence. As the zone temperature travels through the various proportional bands, the output to the associated controlled device ranges from 0 to 100%. Integration may be added to this control loop to eliminate the inherent offset associated with proportional only control.

Return Air Control



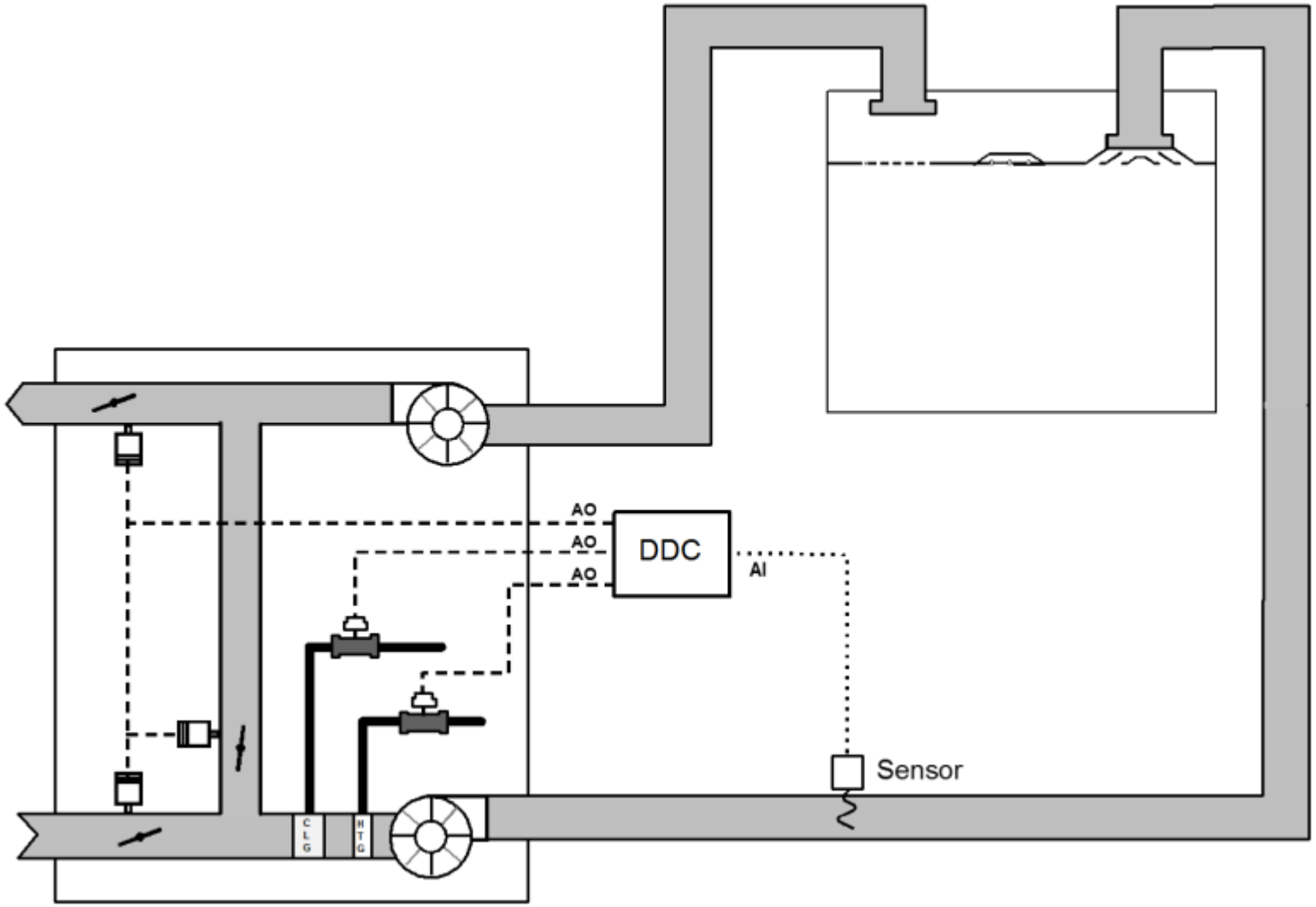
Return Air Control Loop

① Return Air Setpoint
② Heating Deadband
③ Preheat Proportional Band
④ Heating Proportional Band
Heating Integration
⑤ Economizer Proportional Band
Economizer Integration
⑥ Cooling Deadband
⑦ Cooling Proportional Band
Cooling Integration



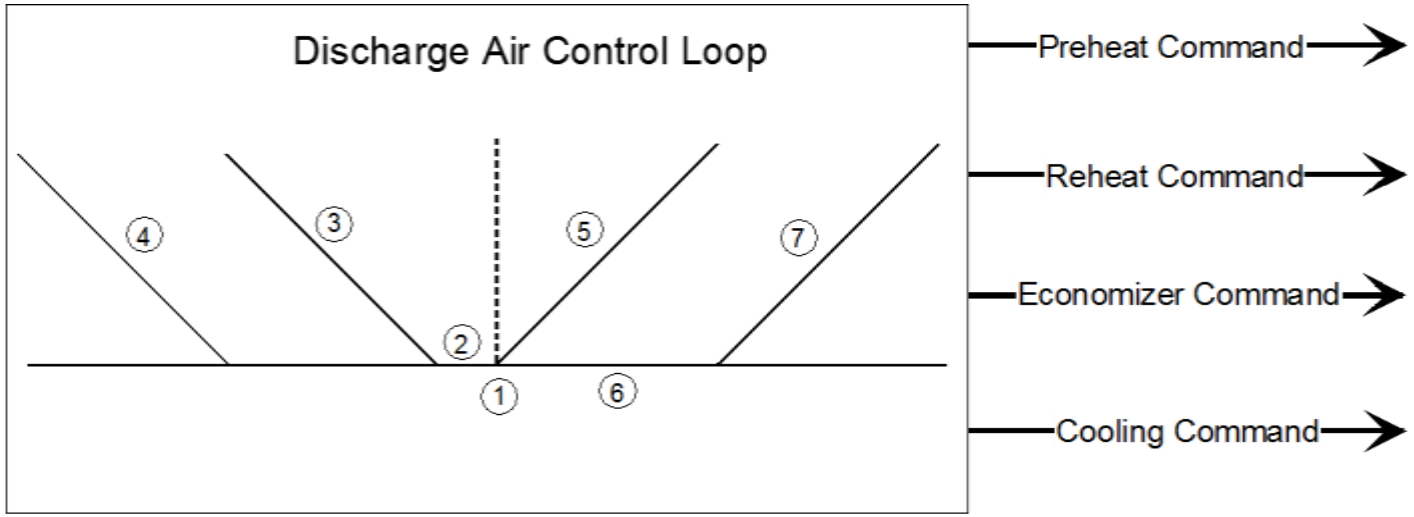
The return air control strategy uses the return air temperature to directly control each controlled device. This strategy commands the preheat (if selected and sequenced) and heating devices in sequence as the return air temperature decreases below the return setpoint minus a heating deadband. As the return temperature increases above the return air setpoint, the return air control strategy controls the outdoor air damper (if selected and sequenced) and mechanical cooling devices in sequence. As the return air temperature varies through the heating and cooling proportional bands, the output to the controlled device ranges between 0 to 100%.

Discharge Air Control



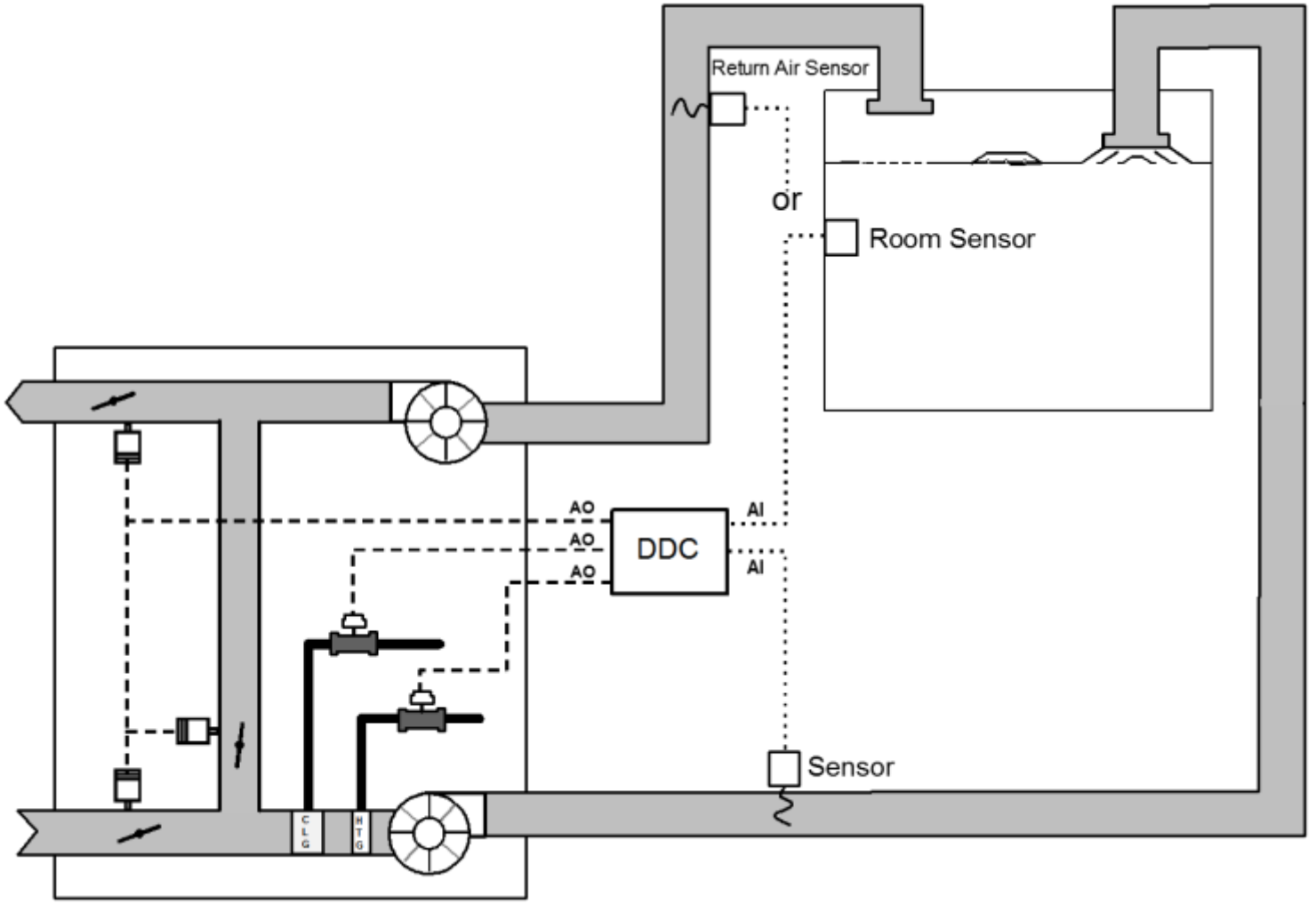
Discharge Air Control Loop

① Discharge Air Setpoint
② Heating Deadband
③ Preheat Proportional Band
④ Heating Proportional Band
Heating Integration
⑤ Economizer Proportional Band
Economizer Integration
⑥ Cooling Deadband
⑦ Cooling Proportional Band
Cooling Integration



The constant discharge air temperature strategy uses the discharge air temperature to directly control each controlled device. It commands, in sequence, the preheat (if selected and sequenced) and heating device as the discharge air temperature decreases into the heating proportional band. As the discharge temperature increases above the discharge air setpoint, the system controls the outdoor air damper (if selected and sequenced) and mechanical cooling devices in sequence. As the discharge temperature varies through heating and cooling proportional bands, the output to the controlled device ranges between 0 to 100%.

Reset of Discharge Air



Discharge Air Reset From Zone Description

The supply air reset from zone temperature strategy resets the discharge air setpoint for heating and cooling.
The zone proportional band is divided by two and each half is active above and below the zone setpoint. As the zone temperature varies away from the zone setpoint within the zone proportional band, it calculates the actual discharge setpoint based on a discharge low limit and discharge reset band.
This strategy uses a discharge sensor to control heating and cooling around the actual discharge setpoint. It controls and sequences the preheat (if selected and sequenced) and heating devices as the discharge temperature decreases below the actual discharge setpoint minus the heating deadband.
The discharge sensor also controls the outside air damper (if selected and sequenced) and mechanical cooling device as the discharge air temperature increases above the actual discharge setpoint plus the cooling deadband. Integration may be added to this control loop to eliminate the inherent offset associated with proportional only control.

Discharge Air Reset From Return Air Description

The supply air reset from return temperature strategy resets the discharge air setpoint for heating and cooling.

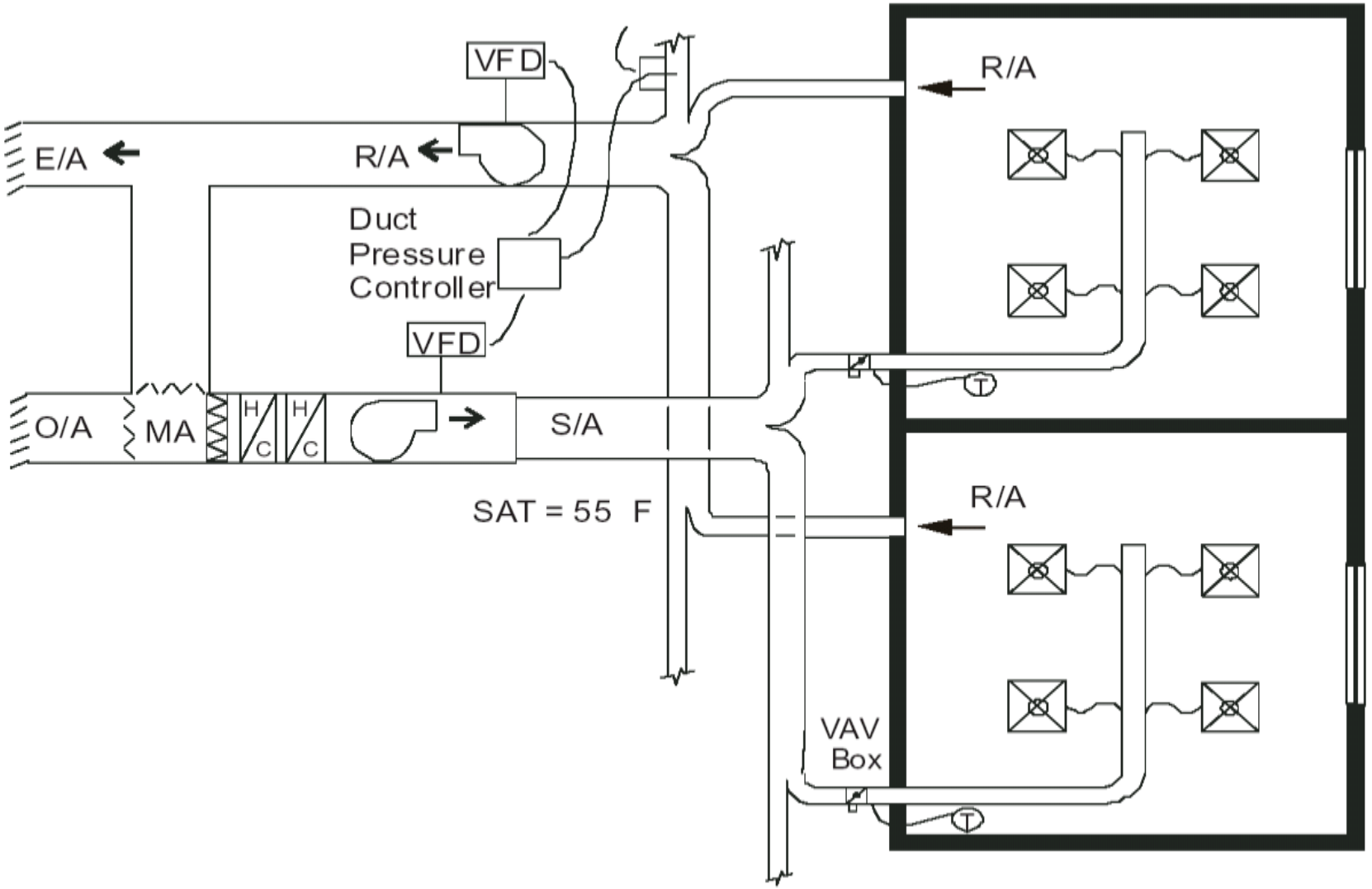
As the return temperature varies below the return high limit and within the return reset band, it calculates a discharge setpoint based on a discharge low limit and discharge reset band. The return proportional band is divided and active above and below the return setpoint.

The discharge low limit establishes the discharge setpoint when the return temperature is at the warmest end of the return proportional band. The value of the discharge reset band is the number of degrees added to the discharge low limit as the return temperature decreases through the return proportional band.

This strategy uses a discharge sensor to control heating and cooling around the calculated discharge setpoint. It controls and sequences the preheat (if selected and sequenced) and heating devices as the discharge temperature decreases below the calculated discharge setpoint minus the heating deadband.

The discharge sensor also controls the outside air damper (if selected and sequenced) and mechanical cooling device as the discharge air temperature increases above the calculated discharge setpoint. As discharge temperature varies through the heating and cooling proportional bands, the outputs to the controlled devices modulate between 0 to 100%. Integration may be added to these control loops to eliminate the inherent offset associated with proportional only control.

Variable Air Volume

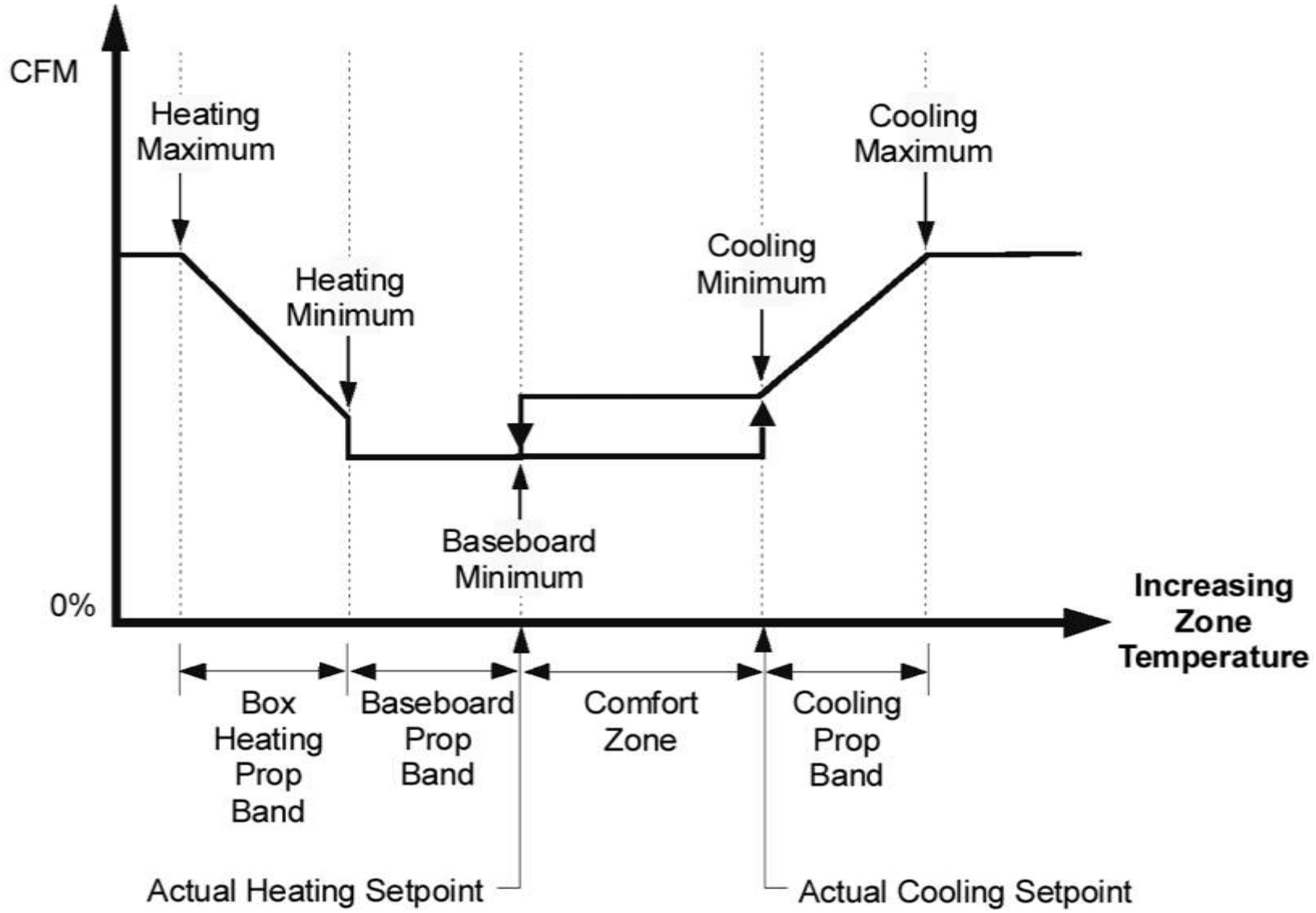


VAV System Description

A VAV system maintains the air supply at a constant temperature while individual zone thermostats vary the flow of air to each space maintaining the desired zone temperature. This is unlike a constant volume system that maintains a constant volume of airflow to the space, but varies the temperature of the air stream in response to space temperature changes. VAV systems are predominantly single duct, but about 15% are dual duct designs.

The air handling system typically maintains about 1 inch W.C. static pressure inside the longest run of duct work away from the supply fan. This ensures that each VAV terminal unit has enough pressure at its inlet to deliver the maximum required flow of air into the space. As each VAV box opens and closes in response to the temperature changes in the space, the static pressure in the air handling system changes. It is the job of the controller at the air handler to modulate the supply fan providing the needed amount of airflow to each VAV box by maintaining the static pressure setpoint.

Typical VAV Terminal Box CFM Control Loop

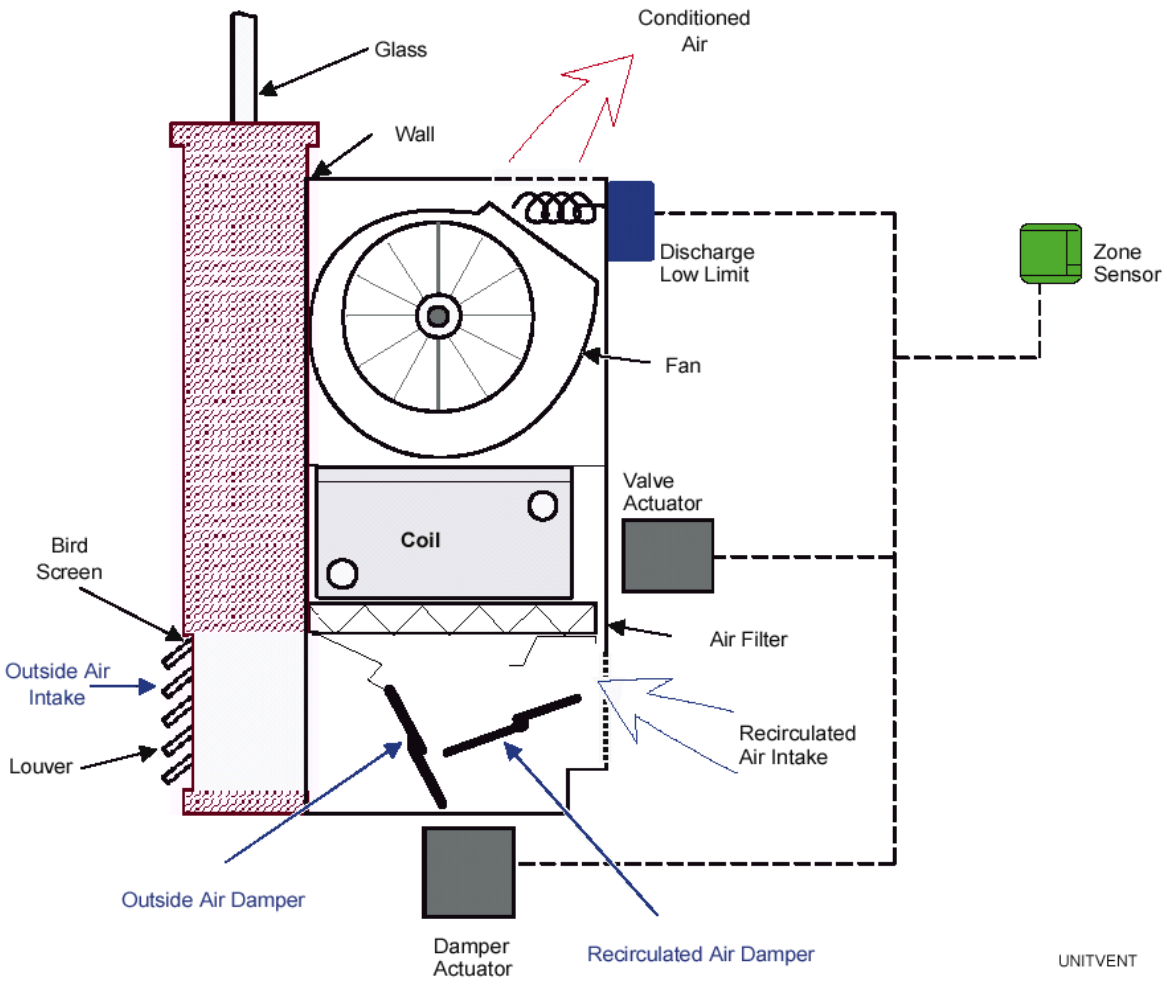


VAV Terminal Box Description

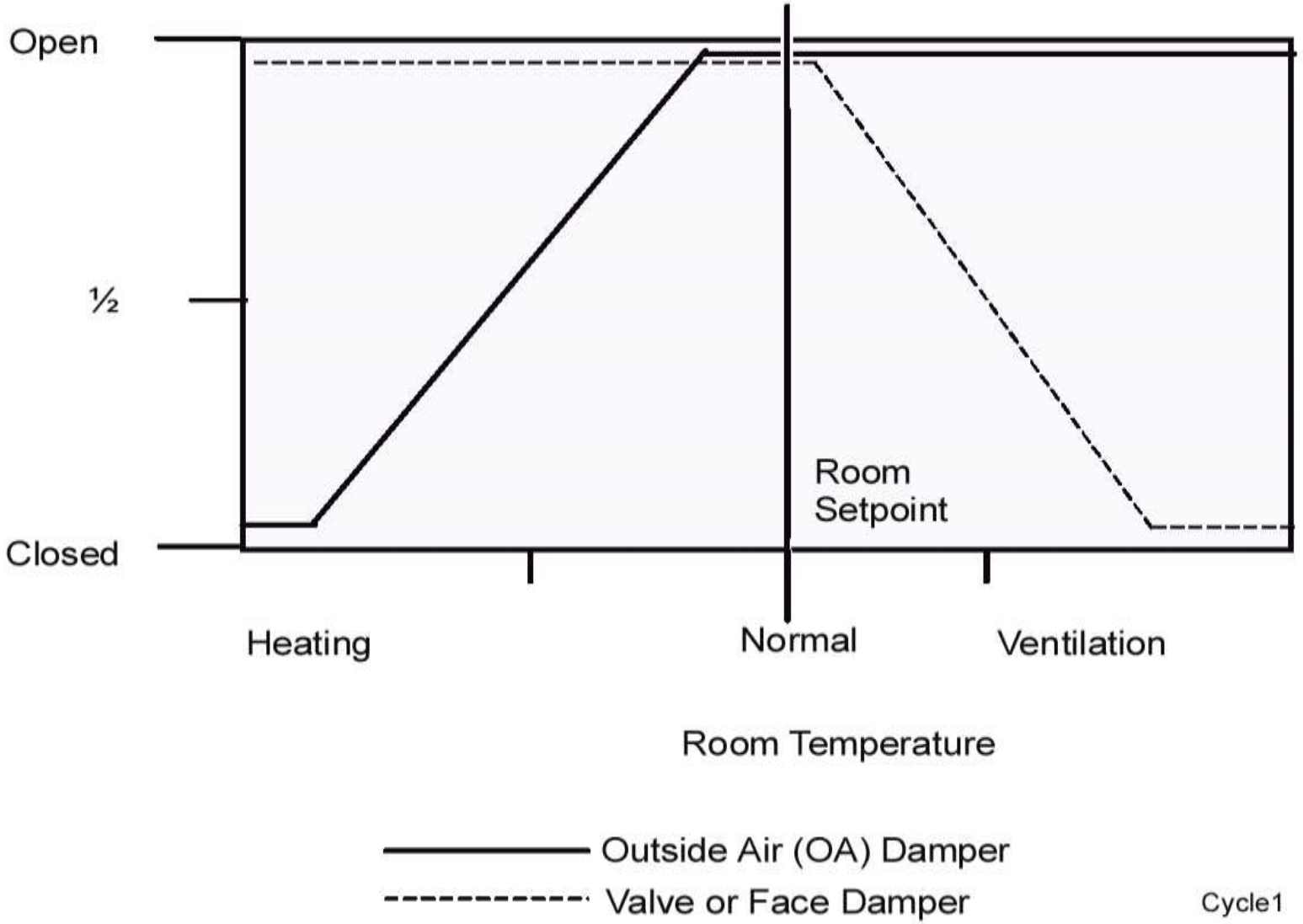
The temperature control loop sequencer compares the zone temperature to the zone setpoint and produces a 0 to 100% output command. The output command feeds into the flow setpoint reset schedules to provide a supply flow setpoint. The flow control loop compares the supply flow setpoint from the reset schedule to the actual flow calculated from the differential pressure input, and produces a 0 to 100% command to the damper.

Unit Vent ASHRAE Cycle I

ASHRAE Cycle I supplies 100% outdoor air at all times. As the room temperature rises into the normal operating range of the zone thermostat, the outdoor air damper is fully opened and the return air damper is closed. The heating valve is controlled by the zone thermostat to maintain setpoint. The discharge air thermostat can override the zone thermostat action on the heating valve to open the valve to maintain a minimum discharge air temperature into the space.



Unit Vent ASHRAE Cycle I Sequence



Proactively diagnosing and correcting equipment issues with Equipment Management

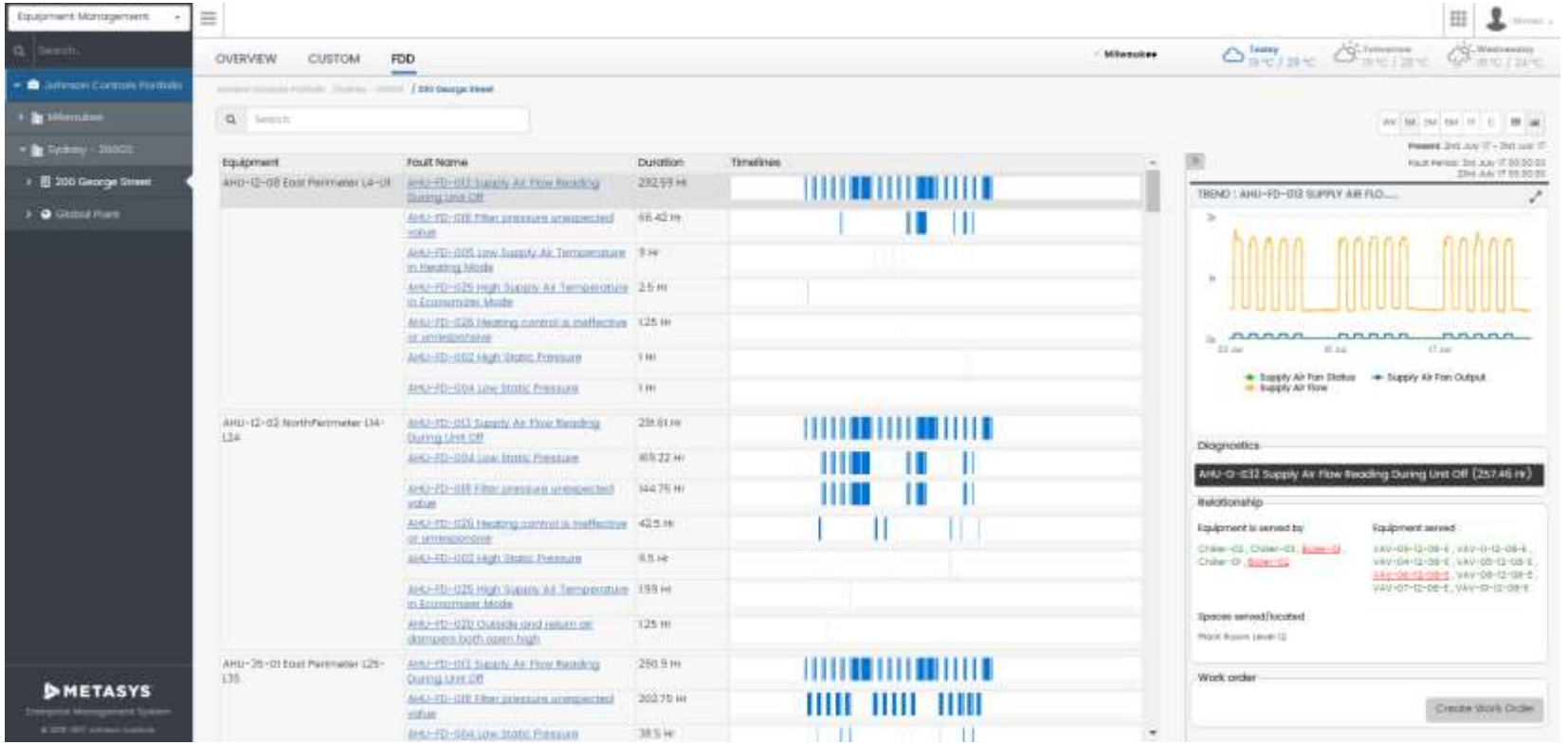
"Provide me the **diagnosis to take corrective action**. And issue a work order… from the same platform."

Equipment Fault Detection & Diagnostics **uncover critical faults and root cause.**

*Visual display zeros in on **preventative solutions** and allows user to **create appropriate work order**.*

Customer Benefits:

- Reduces time on task
- Extends equipment life
- Closes the loop – single platform solution



Customer & Partner Solution Examples

- New Facility Maintenance Processes and KPIs
- Reduced Operation & Maintenance (O&M) Risks
- Improved O&M Staff Productivity & Effectiveness
- Reduced Facility Work Order Backlogs
- Facility O&M Root Cause Troubleshooting Tools
- Work Order System Updates with onsite Coaching
- Career & Personal Development Maps
- Onsite Training, Mentoring, and Cheat Sheets
- Facility O&M Center of Excellence Updates & Tools
- Improved Compliance with Codes & Regulations

Questions?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