ASHRAE Guideline 36

High performance sequence
of operations for HVAC systems

The power behind **your mission**

Johnson Controls

ASHRAE Guideline 36: Agenda

- **Purpose and Scope**
- **Simplified Summary**
- **Benefits**
- ***General Logic – Thermal and Ventilation***
- ***VAV Terminal Units and AHU***
- ***General Control Logic***
- ***Alarms, Alarm Management, and Faults***
- ***Tools and Resources***

ASHRAE Guideline 36: Purpose and Scope

Purpose: The purpose of this guideline is to provide uniform sequences of operation for (HVAC) systems that are intended to maximize energy efficiency and performance, provide control stability, and allow for real-time fault detection and diagnostics.

Scope:

1. This guideline provides detailed sequences of operation for HVAC systems.

2. This guideline describes functional tests that, when performed, will confirm implementation of the sequences of operation. (Future)

ASHRAE Guideline 36: Simplified Summary

G36-2018 focuses on Air-side HVAC systems (Link)

VAV Terminal Units: single duct, dual duct, and fan powered

VAV AHUs: single zone vav and multi-zone vav

General Logic

Thermal Zone

Ventilation Zone

Control Logic

Addenda (Link)

Water side HVAC equipment:

CHW Distribution, Chiller Configuration, Chiller Types, Pump Configurations, WSE, & Heat Rejection

HW Distribution, Boiler Types, & Pump Configurations

ASHRAE Guideline 36: Generic Thermal Zone Logic

Temperature setpoints

- Every zone has occupied and unoccupied setpoints
- Every zone has separate heating and cooling setpoints
- Setback of 1 degree with occ sensor
- Extreme setback with window switch (40/120)

Zone groups

Zones operate under the same AHU and schedule

AHU can have multiple zone groups

Zone group modes

Mode determines setpoints and ventilation

- Occupied, warm-up, cooldown, setback, freeze protect setback, setup, unoccupied
- Highest zone mode sets mode for zone group

ASHRAE Guideline 36: Ventilation Zone Logic

- **Minimum Outdoor Air**
- Calculate zone min OA based on 62.1

  Voz = (Vbz-A* + Vbz-P*)/Ez

  Ez = 1.0 Cooling and 0.8 Heating

  Vbz-A – Area outdoor air rates

  Vbz-P – Occupant outdoor air rates
- CO2

  Vmin = 0% when CO2@ SP-200 ppm

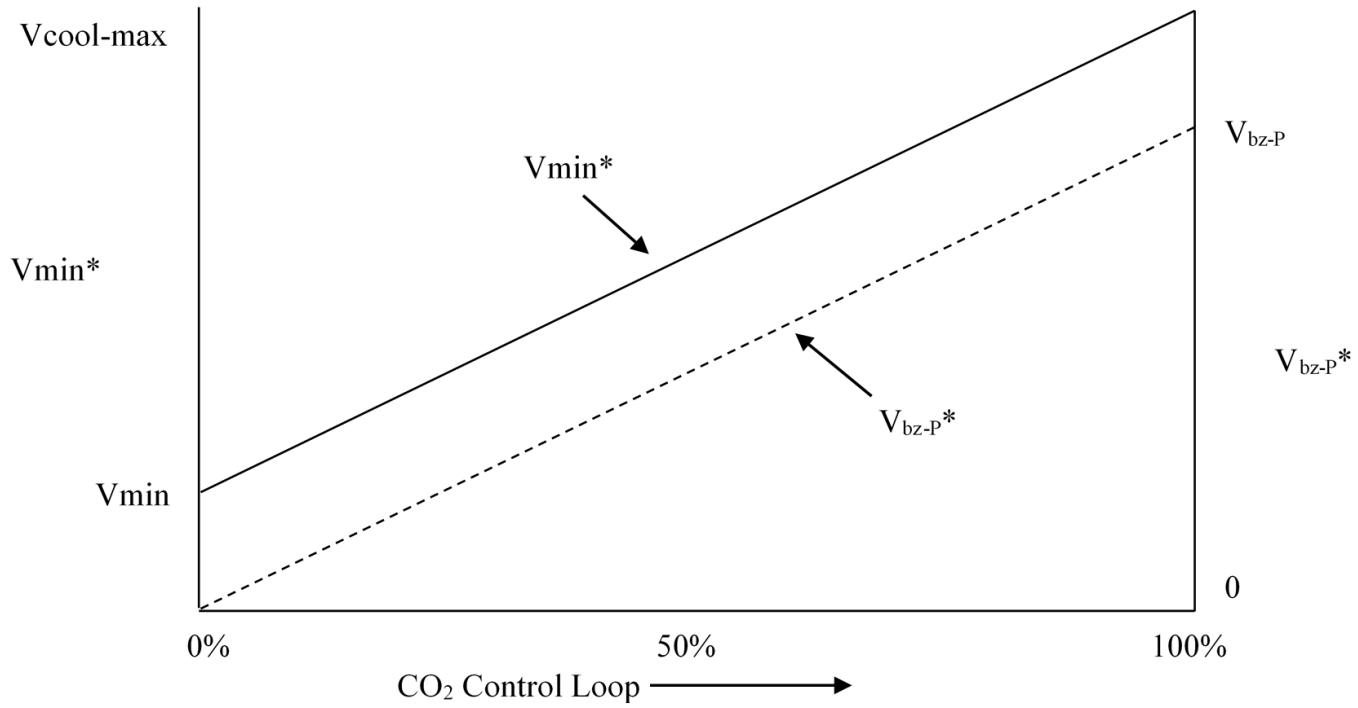
  Vmin = 100% when CO2@ SP

- Calculate Zone Min Primary Airflow

  Vpz-min = Voz if AHU is 100% OA

  Vpz-min = 1.5*Voz if AHU <100% OA

- Zone OA and primary airflow sent to AHU
- Time Averaged Ventilation



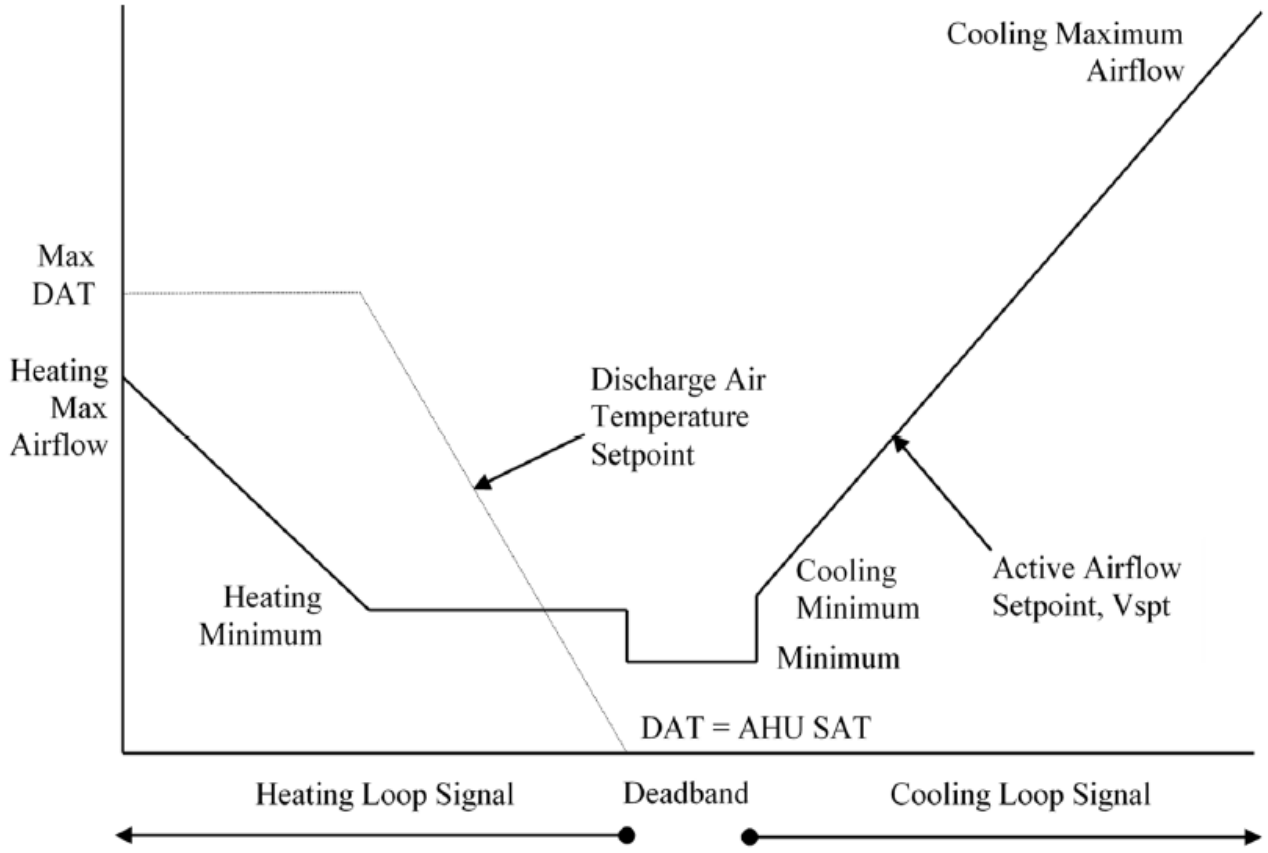
ASHRAE Guideline 36: VAV Terminal Units

- Zone Group mode sets the active min and max flow setpoints
- Different heating and cooling max
- Heating min/max non-zero in Cooldown
- Warmup/Setback use Vheat-max for Heating minimum

Set point	Occupied	Cooldown	Setup	Warm-up	Setback	Unoccupied
Cooling maximum	Vcool-max	Vcool-max	Vcool-max	0	0	0
Cooling minimum	Vmin	0	0	0	0	0
Minimum	Vmin	0	0	0	0	0
Heating minimum	Max (Vheat-min, Vmin)	Vheat-min	0	Vheat-max	Vheat-max	0
Heating maximum	Max (Vheat-max, Vmin)	Vheat-max	0	Vcool-max	Vcool-max	0

ASHRAE Guideline 36: VAV Terminal Units

- Lower fan energy
- Lower heating energy
- Reduces stratification
- Meets 90.1/T24



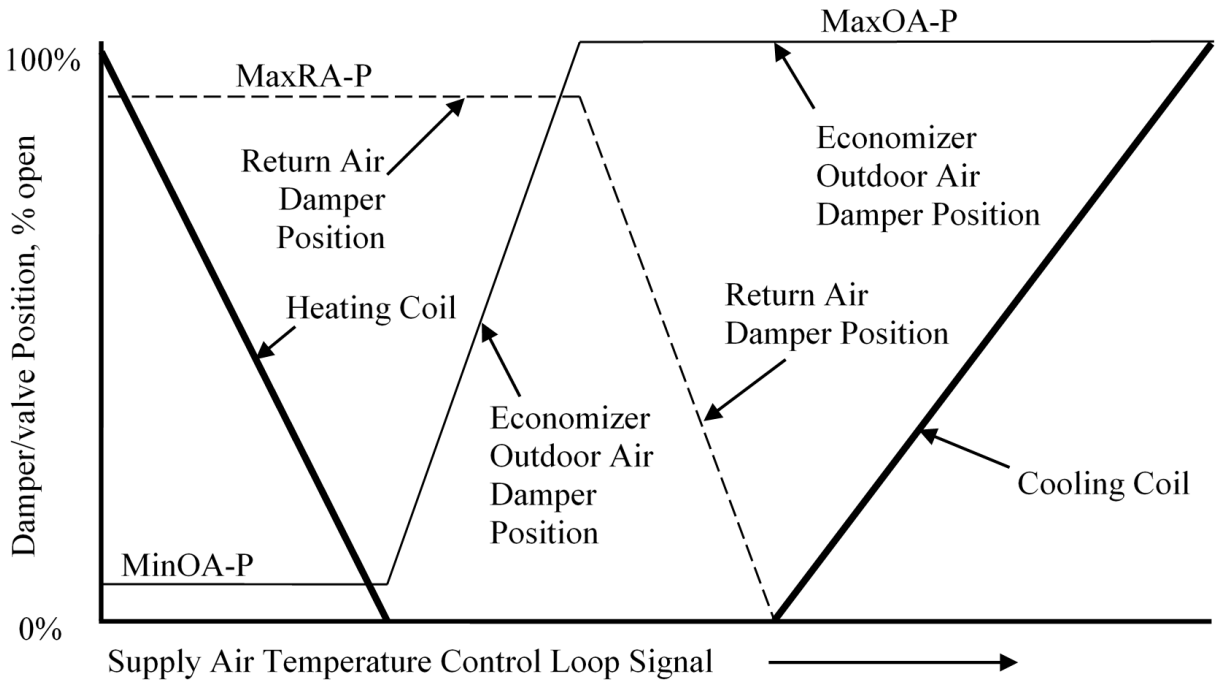
ASHRAE Guideline 36: Multi-Zone AHU

Equipment Configuration

- OA Damper
  - Common Damper
  - Separate Dedicated Damper
- Relief Dampers w/o Fans
- Relief Fans
- Return Fans

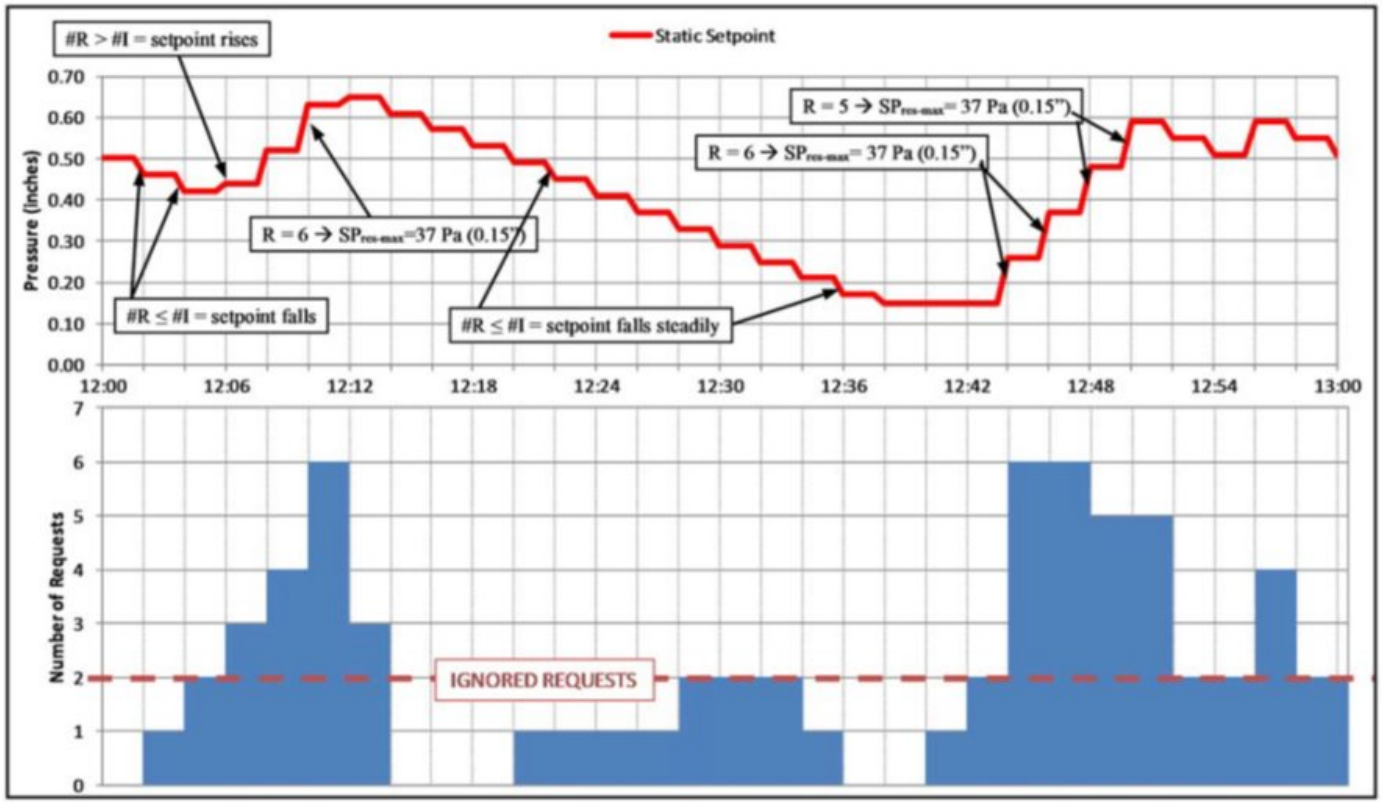
Building Pressure Control Options

- Building Static Control
- Airflow Tracking (RF Option Only)



ASHRAE Guideline 36: General Control Logic

- Trim and respond:
  - Static pressure SP reset
  - SP trimmed at fixed rate
  - Zones generate requests
  - SP responds to requests
- Minimizes fan energy
- Easier to tune than PID
- Responds quickly
- Easy to exclude rogue zones



ASHRAE Guideline 36: Alarms and Alarm Suppression

- **Four Alarm Levels**
  - Level 1: Life Safety Message
  - Level 2: Critical Equipment Message
  - Level 3: Urgent Message
  - Level 4: Normal Message

Hierarchical Alarm Suppression

- If upstream “source” is in alarm, then downstream “load” alarm is suppressed
- Source and loads relationships are separate for heating, cooling, and airflow
- Upstream equipment passes a SystemOK to downstream devices

ASHRAE Guideline 36: Automatic Fault Detection and Diagnostics

- Detects AHU faults based on BAS inputs and outputs from NIST research
- Operating state (OS) of AHU based on heating, cooling, and economizer.

Operating state	Heating valve position	Cooling valve position	Outdoor air damper position
#1 Heating	> 0	= 0	= min
#2 Free cooling, modulating OA	= 0	= 0	Min < X < 100%
#3 Mechanical + economizer cooling	= 0	> 0	= 100%
#4 Mechanical cooling, min OA	= 0	> 0	= min
#5 Unknown or dehumidification	No other OS applies		

ASHRAE Guideline 36:
Automatic Fault Detection and Diagnostics

- 15 possible faults conditions (FC) depend on Operating state (OS) of AHU
- Minimize false alarms (sensor error, rolling ave, suspend during OS change)

FC #7	**Equation**	$SAT_{AVG} < SATSP - \varepsilon_{SAT}$ and $HC \geq 99\%$	**Applies to OS #1**
	Description	SAT too low in full heating	
	Possible Diagnosis	▪ SAT sensor error ▪ Cooling coil valve leaking or stuck open ▪ Heating coil valve stuck closed or actuator failure ▪ Fouled or undersized heating coil ▪ HW temperature too low or HW unavailable ▪ Gas or electric heat is unavailable ▪ DX cooling is stuck on ▪ Leaking or stuck economizer damper or actuator	

ASHRAE Guideline 36: Benefits

- ***Benefits to Engineers***
- *Reduced design engineering time.*
- *G36 under continuous monitoring*

- ***Benefits to Owners***
- *Reduced energy consumption*
- *Improved indoor air quality*
- *Reduced energy consumption and reduced system down-time with the inclusion of FDD.*

- ***Benefits to Controls Contractor***
- *Reduced programming and commissioning time for contractors.*
- *Reduced errors and misinterpretations of sequence of operations*

ASHRAE Guideline 36: How will it get Specified?

- **Building owners**
- Request ASHRAE Guideline 36 be used.

- **Engineers**
- Need to include it in their specifications

    1) Cut and paste into their specs

    2) Specify by section number

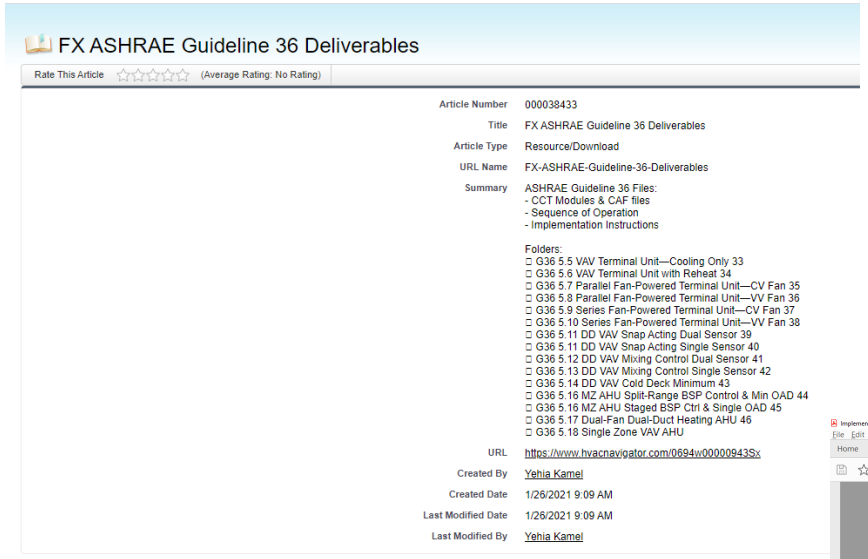
    3) General statement that control sequences implemented with ASHRAE Guideline 36

ASHRAE Guideline 36: HVAC Navigator (Link Here)

- 15 sample applications
- 70 custom modules
- 213 pages of instructions

Summary ASHRAE Guideline 36 Files:
- CCT Modules & CAF files
- Sequence of Operation
- Implementation Instructions

Folders:
- ☐ G36 5.5 VAV Terminal Unit—Cooling Only 33
- ☐ G36 5.6 VAV Terminal Unit with Reheat 34
- ☐ G36 5.7 Parallel Fan-Powered Terminal Unit—CV Fan 35
- ☐ G36 5.8 Parallel Fan-Powered Terminal Unit—VV Fan 36
- ☐ G36 5.9 Series Fan-Powered Terminal Unit—CV Fan 37
- ☐ G36 5.10 Series Fan-Powered Terminal Unit—VV Fan 38
- ☐ G36 5.11 DD VAV Snap Acting Dual Sensor 39
- ☐ G36 5.11 DD VAV Snap Acting Single Sensor 40
- ☐ G36 5.12 DD VAV Mixing Control Dual Sensor 41
- ☐ G36 5.13 DD VAV Mixing Control Single Sensor 42
- ☐ G36 5.14 DD VAV Cold Deck Minimum 43
- ☐ G36 5.16 MZ AHU Split-Range BSP Control & Min OAD 44
- ☐ G36 5.16 MZ AHU Staged BSP Ctrl & Single OAD 45
- ☐ G36 5.17 Dual-Fan Dual-Duct Heating AHU 46
- ☐ G36 5.18 Single Zone VAV AHU



FX ASHRAE Guideline 36 Deliverables

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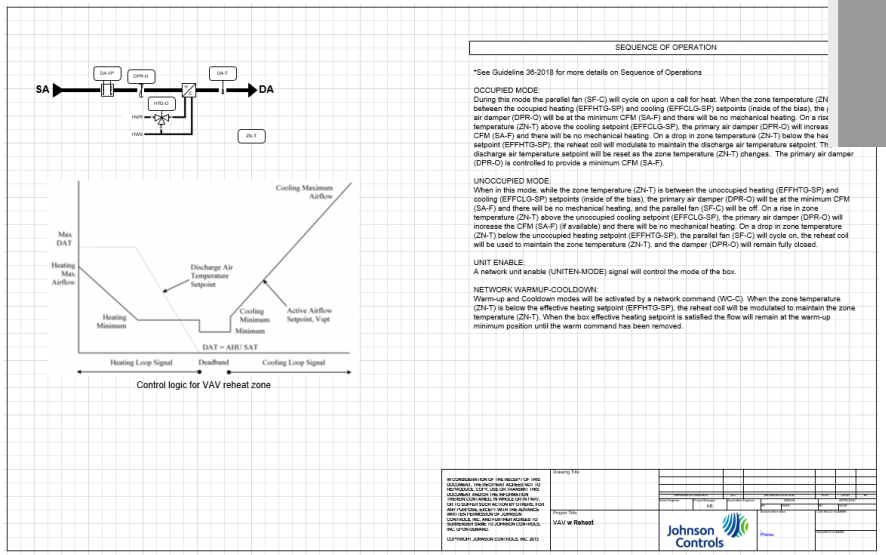

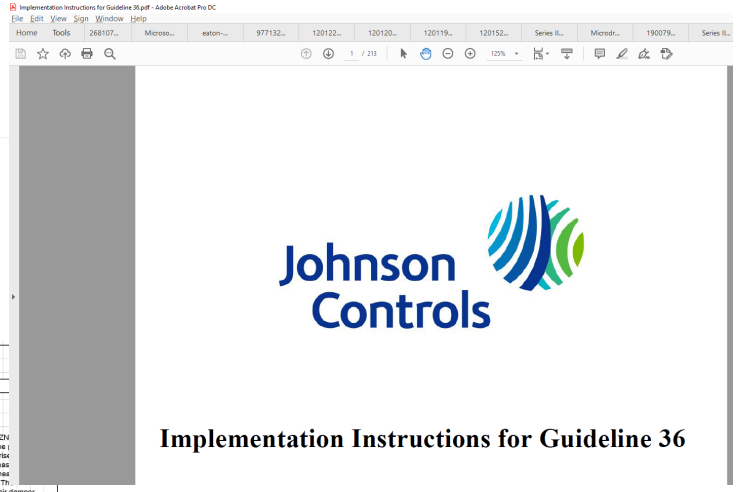

Implementation Instructions for Guideline 36

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ASHRAE Guideline 36: Conclusion

Reduce Cost and Errors

Writing, Programming, and Commissioning

Reduce Misinterpretations of sequence of operations

Pretested Algorithms

Meet Current Standards

Energy – ASHRAE 90.1 and Title 24

Ventilation – ASHRAE 62.1 and Title 24

Comfort – ASHRAE 55

Improve Reliability and Operation

Hierarchical Alarms

AFDD

Thank you!

Questions