**T26-04 Archbishop Denis O'Connor Catholic High School HVAC Replacement**
**Addendum No 2**

**Closing Date Revised: Monday May 25, 2026, 2:00 PM**

**Addendum Date:** Wednesday, May 6, 2026

**Issued by:** Purchasing Services
Durham Catholic District School Board

This addendum will form a part of the bid documents for the above noted Bid and shall be read in conjunction herewith. This addendum will take precedence over all requirements of the original bid documents and any addenda issued previously.

**Bidders shall acknowledge receipt of this addendum with their electronic bid submission on the declaration page in the bidding system.**

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**REVISION**

**1.4 RFT Timetable**

**DELETE**

| | |
|---|---|
| Deadline for Proponent Questions | May 4, 2026 @ 2:00 p.m. EST |
| Anticipated last Addendum date | May 6, 2026 |
| Proposal Submission Deadline | May 14, 2025 @ 2:00 p.m. |
| Anticipated Selection of Proponent | May 2026 |

**ADDITION**

| | |
|---|---|
| Deadline for Proponent Questions | May 13, 2026 @ 2:00 p.m. EST |
| Anticipated last Addendum date | May 15, 2026 |
| Proposal Submission Deadline | May 25, 2025 @ 2:00 p.m. |
| Anticipated Selection of Proponent | May 2026 |

## CHANGES TO SPECIFICATIONS AND DRAWINGS

See Files Attached:

1. 25119 - DOC Mechanical Upgrades - Addendum 2
2. 25119 - DOC Mechanical Upgrades - Controls Specifications
3. 25119 - M020 CONTROLS
4. 25119 - M301 MECHANICAL ROOMS 205, 214, 235

[End of Addendum No 2]

rybka Ellard Willson
23 Lesmill Road, Unit 410
Toronto, ON, Canada M3B 3P6
905.940.3100 905.940.2139

**The following additions, deletions, amendments and/or items of clarification are hereby made an integral part of the Tender Documents. All revisions shall be made to the drawings and/or specifications and all costs for same shall be included in the Stipulated Price.**

## CHANGES TO SPECIFICATIONs

The following controls specifications have been issued:

25 05 00-Common Work Results for Integrated Automation
25 05 53-Identification for Integrated Automation
25 10 01-EMCS Local Area Network (LAN)
25 24 00-Integrated Automation System Architecture Requirements
25 30 00-Integrated Automation Instrumentation and Terminal Devices
25 35 13-Integrated Automation Actuators and Operators
25 41 00-Building Automation Controllers
25 45 00-Centralized Building Management System
25 70 00-Integrated Automation Building Systems Integration
25 90 00-Integrated Automation Control Sequences

## CHANGES TO DRAWINGS

### DRAWING M020 CONTROLS (ISSUED).

- New Controls Drawing M020 issued.

### DRAWING M301 (ISSUED).

- Full unit AHU-3 to be demolished and replaced with new pre-tendered unit. AHU amount to be paid using cash allowance. The preliminary shop drawings for the unit can be found attached to this document. New layout detail drawing and notes edited to reflect change.

**END OF ADDENDUM 2**

**HTS Oshawa**

2001 Thickson Rd, South
Unit #11
Whitby, ON  L1N 6J3
T 905.579.6700
F 905.597.5290

ontario.htseng.com

SUBMITTAL DATA
APPROVAL REQUIRED

# Air Handling Unit AHU-3

# Technical Information And Drawings

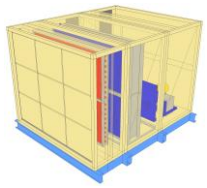
Notes:

1) Electrical: AHU fan section ships with an external junction box, factory wired to the dual fan array. A single VFD for the array ships loose with integral motor overloads, and dedicated contacts for powering each motor in the array. Electrical division to field wire from the VFD to the junction box for each motor.
    a. 575V/3ph
    b. 2 x 7.5hp SF motors

2) Unit Information:
    a. 2” MERV 8 filters
    b. Hot water heating coil
    c. DX cooling coil, R410A with stainless steel casing, stainless steel drain pan
    d. Dual supply fan array, airfoil centrifugal plenum fans. Motors factory wired to external junction box.
    e. VFD ships loose for field mounting & wiring to junction box

3) Warranty:
    a. 1 year parts only

| Job Information | Technical Data Sheet |
|---|---|
| **Job Name** | 22600705 - DCDSB Archbishop DOC |
| **Date** | 04 May 2026 |
| **Submitted By** | Ellard Willson Engineering |
| **Software Version** | 13.95 |
| **Unit Tag** | AHU-3 |



## Unit Overview

| Model Number | Supply | | | | | |
|---|---|---|---|---|---|---|
| | Air Volume cfm | Static Pressure | | External Dimensions | | |
| | | External inWc | Total inWc | Height in | Width in | Length in |
| CAH025GDGM | 11760 | 2.00 | 3.44 | 66* | 76* | 96 |

**Not including base rails, coil connectors, drain connectors and control boxes.*

## Unit

| | | | |
|---|---|---|---|
| **Model Number:** | CAH025GDGM | | |
| **Approval:** | ETL Listed / ETL Listed to Canadian Safety Standards (ETL Label / ETLc Label) | | |
| **Outer Panel:** | Painted 24 gauge G60 Galvanized Steel (3000 hr. Salt Spray ASTM B-117) | | |
| **Liner:** | 24 gauge Galvanized Steel (unless noted per section) | | |
| **Insulation:** | R-13 Injected Foam | | |
| **Unit Configuration:** | Inline horizontal | **Drive (Handling) Location:** | Left |
| **Base:** | 6" formed channel | **Wall Thickness:** | 2 in |
| **Altitude:** | 0 ft | **Parts Warranty:** | Standard One Year |

## Panel Filter

Component: 1 | Length: 12 in | Shipping Section: 1

| Type | Efficiency | Nominal Face Velocity | Actual Face Velocity | Actual Face Area | Air Volume | Filter Loading |
|---|---|---|---|---|---|---|
| Pleated | MERV 8 | 392 ft/min | 413 ft/min | 28.5 ft² | 11760 cfm | Side |

| Air Pressure Drop | | | | Number of Filters | Height | Width | Depth |
|---|---|---|---|---|---|---|---|
| Clean Air | Mean Air | Dirty Air | User Spec | | | | |
| **0.18** inWc | 0.59 inWc | 1.00 inWc | N/A | 9 | 20 in | 24 in | 2 in |

**Door**

| Location | Width | Opening |
|---|---|---|
| Drive side | 8 in | Outward |

## Hot Water Coil

Component: 2 | Length: 12 in | Shipping Section: 1

| Coil Model | Total Capacity | Number of Coils | Number of Rows | Fins per Inch | Tube Diameter | Tube Spacing (Face x Row) |
|---|---|---|---|---|---|---|
| 5WH0701B | 338862 Btu/hr | 2 | 1 | 7 | 0.625 in | 1.50 in x 1.299 in |

| Coil Operating Weight | Coil Dry Weight |
|---|---|
| 127 lb | 79 lb |

| Air Volume | Air Temperature | | Coil Air Pressure Drop | Finned Height | Finned Length | Face Area | Face Velocity |
|---|---|---|---|---|---|---|---|
| | Entering Dry Bulb | Leaving Dry Bulb | | | | | |
| 11760 cfm | 35.0 °F | 61.4 °F | 0.08 inWc | 27 in | 60 in | 22.50 ft² | 523 ft/min |

**Fluid**

| Entering | Leaving | Flow Rate | Pressure Drop | Velocity | Fluid Volume | Fluid Weight |
|---|---|---|---|---|---|---|
| 170.0 °F | 148.9 °F | 34.60 gpm | 2.70 ftHd | 2.10 ft/s | 5.0 gal | 48.00 lb |

| Connection [Data Per Coil] | | | | Glycol Type | Min. Fin Surface Temp. | Min. Tube Wall Surface Temp. | Fouling Factor |
|---|---|---|---|---|---|---|---|
| Type | Size | Location | Material | | | | |
| Threaded | 1.50 in | Drive side | Carbon steel | Propylene (40%) | 148.9 °F | 148.9 °F | 0.000 |

| Material | | | | Turbospiral |
|---|---|---|---|---|
| Fin | Tube | Header | Case | |
| Aluminum .0075 in | Copper .020 in | Copper | Galv. steel | Yes |

**AHRI 410 Certification**

Coil is NOT certified by AHRI

## Direct Expansion Coil

Component: 3 | Length: 34 in | Shipping Section: 2

| Coil Model | Total Capacity | Sensible Capacity | Number of Coils | Number of Rows | Fins per Inch | Tube Diameter | Tube Spacing (Face x Row) |
|---|---|---|---|---|---|---|---|
| 5EJ1008B | 587964 Btu/hr | 342100 Btu/hr | 2 | 8 | 10 | 0.625 in | 1.50 in x 1.299 in |

**Coil Operating Weight**

704 lb

| Air Volume | Air Temperature | | | | Coil Air Pressure Drop | Finned Height | Finned Length | Face Area | Face Velocity |
|---|---|---|---|---|---|---|---|---|---|
| | Entering | | Leaving | | | | | | |
| | Dry Bulb | Wet Bulb | Dry Bulb | Wet Bulb | | | | | |
| 11760 cfm | 82.0 °F | 70.0 °F | 55.4 °F | 54.4 °F | 1.11 insWg | 27 in | 63 in | 23.62 ft² | 498 ft/min |

| Fluid | | Sub-Cooled Refrigerant Liquid Temp. | Suction Vapor Superheat Temp. at Coil Outlet | Design Saturated Condensing Temp. | Total Refrigerant Weight |
|---|---|---|---|---|---|
| Suction Temp. | Refrigerant | | | | |
| 47.0 °F | R410a | 110.0 °F | 8.0 °F | 110.0 °F | 98.00 lb |

| Connection [Data Per Coil] | | | | | Min. Fin Surface Temp. | Min. Tube Wall Surface Temp. |
|---|---|---|---|---|---|---|
| Type | Liquid [Qty - Size] | Suction [Qty - Size] | Location | Material | | |
| OD Sweat | 2-1.13 in | 2-1.63 in | Drive side | Copper tube | 32.0 °F | 32.0 °F |

| Material | | | | Drain Pan | Drain Side |
|---|---|---|---|---|---|
| Fin | Tube | Header | Case | | |
| Aluminum .0075 in | Copper .020 in | Copper | Stainless steel | Stainless steel | Drive side |

*Total Refrigerant Weight is the total for all circuits of all coils in this coil section and is estimated. Refer to the AHU and Condensing Unit IOMs for recommendations on system start-up.*

*Minimum allowable face velocity = 150 fpm*

**AHRI 410 Certification**

Coil is NOT certified by AHRI

**Door**

| Location | Width | Opening |
|---|---|---|
| Drive side | 12 in | Outward |

## Supply Fan

Component: 4 | Length: 38 in | Shipping Section: 3

### Fan Performance

| Air Volume* | Static Pressure | | | Fan Energy Index(FEI) | Total Input Power | Fan Shaft Power* | Fan Wheel Speed | | Redundancy(N-1) | Fan Circuit | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | External | Total | Cabinet | | | | Operating | Maximum | | MOP | MCA |
| 5880 cfm | 2.00 inWc | 3.44 inWc | 0.07 inWc | 0.94 | 11.5 kW | 6.13 BHP | 3299 rpm | 3650 rpm | 63.3 % | 20.0 A | 16.2 A |

### Fan Data

| Fan Type | Blade Type / Class | Nominal Fan Size | Quantity of Fans | Wheel Diameter | Material Type | Number of Blades | Discharge | Motor Location |
|---|---|---|---|---|---|---|---|---|
| Centrifugal - Plenum | Airfoil / 2 | DDPL16 | 2 | 15.75 in | Aluminum | 9 | Top, single opening | Behind Fan |

### Motor Data

| Power* | Electrical Supply | Speed | Efficiency | Enclosure | Frame Size | Supplier | Number of Poles | Lock Rotor Current* | Full Load Current* |
|---|---|---|---|---|---|---|---|---|---|
| 7.5 HP | 575/60/3 V/Hz/Phase | 3500 rpm | Premium | ODP | 184 T frame | Generic | 2 | 71.50 A | 7.18 A |

### Fan Options

| | |
|---|---|
| **Isolator Type:** | Spring |

### VFD/Starter/Disconnect Data

| | | | |
|---|---|---|---|
| **Selection Type:** | External J-Box | **Vendor:** | Factory Standard |
| **Voltage:** | 575 V | **Height x Width x Depth:** | 6.00 in x 6.00 in x 4.00 in |
| **Mounting:** | Door Side | **Enclosure:** | NEMA 1 |

### Door

| Location | Width | Opening |
|---|---|---|
| Drive side | 14 in | Outward |

### Notes

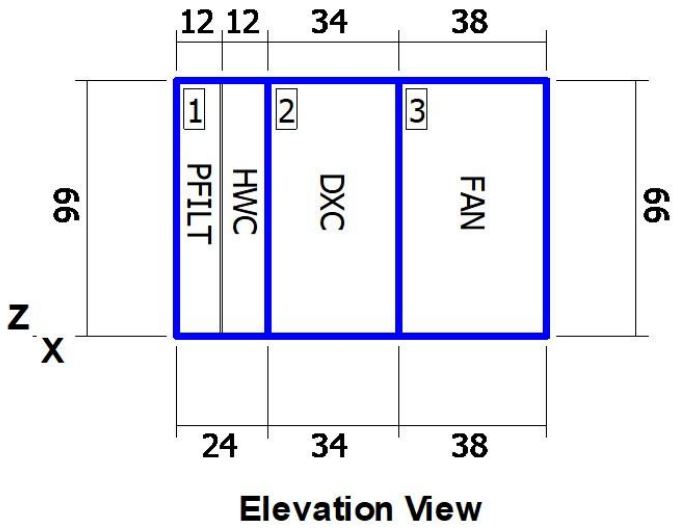
** after a unit label denotes the data per fan.*

## Unit Sound Power (dB)

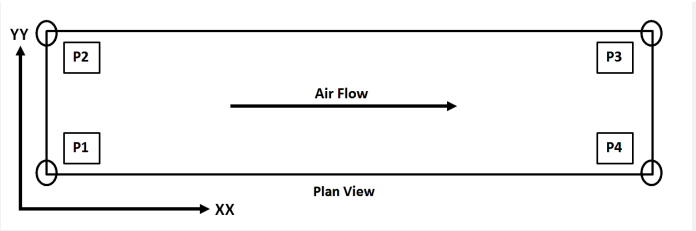
| Type | 63 Hz | 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | 8000 Hz |
|---|---|---|---|---|---|---|---|---|
| **Radiated:** | 78 | 76 | 69 | 79 | 73 | 66 | 58 | 52 |
| **Unit Discharge:** | 88 | 86 | 85 | 96 | 95 | 94 | 96 | 91 |
| **Unit Return:** | 80 | 77 | 79 | 92 | 82 | 81 | 80 | 76 |

## Shipping Section Details

| Section | Length | Weight | Corner Weights (lb) | | | | Center of Gravity (in) | | |
|---|---|---|---|---|---|---|---|---|---|
| | in | lb | P1 | P2 | P3 | P4 | XX | YY | ZZ |
| 1 | 24 | 719 | 153 | 159 | 207 | 201 | 14 | 39 | 34 |
| 2 | 34 | 1319 | 390 | 425 | 270 | 234 | 13 | 40 | 33 |
| 3 | 38 | 1164 | 321 | 340 | 261 | 241 | 16 | 39 | 29 |
| **Entire Unit** | **96** | **3202** | **815** | **875** | **786** | **726** | **45** | **39** | **32** |




Elevation View




*NOTE: Special components aren't included in the corner weights and center of gravity data.*

*NOTE: Shipping weights listed do not include weight of water (listed in coil section(s) above.*

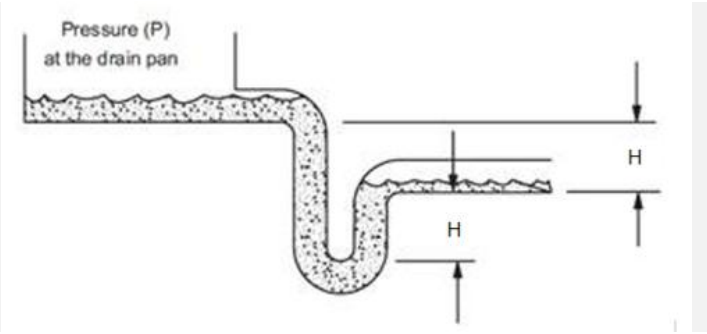
| Shipping Protection | None |
|---|---|

## Supply Static Pressure Drop

| Component | Option | Static Pressure Drop |
|---|---|---|
| Panel Filter | Panel Filter | 0.18 insWg |
| Hot Water Coil | Hot Water Coil | 0.08 insWg |
| DX Coil | DX Coil | 1.11 insWg |
| Supply Fan | Cabinet | 0.07 insWg |
| | | |
| External Static | External Static | 2.00 insWg |
| | | |
| **Total Supply Fan Static** | | 3.44 insWg |

## Minimum Recommended Drain Pan Trap Dimensions

| Shipping Section | Component | H |
|---|---|---|
| 2 | DX Coil | 3.24 |




*Dimensions provided as a courtesy and are recommended minimums only. Daikin is not responsible for supplying or designing drain pan traps and is not responsible for any damage caused by incorrect trap heights. The dimensions listed above should be reviewed and approved by a licensed plumbing professional.*

*This calculation is based on an assumption that 0.25 inches of the external static pressure is in the return duct and the remainder is in the supply duct. If actual conditions vary from this assumption then contact Applications for new trap height recommendations.*

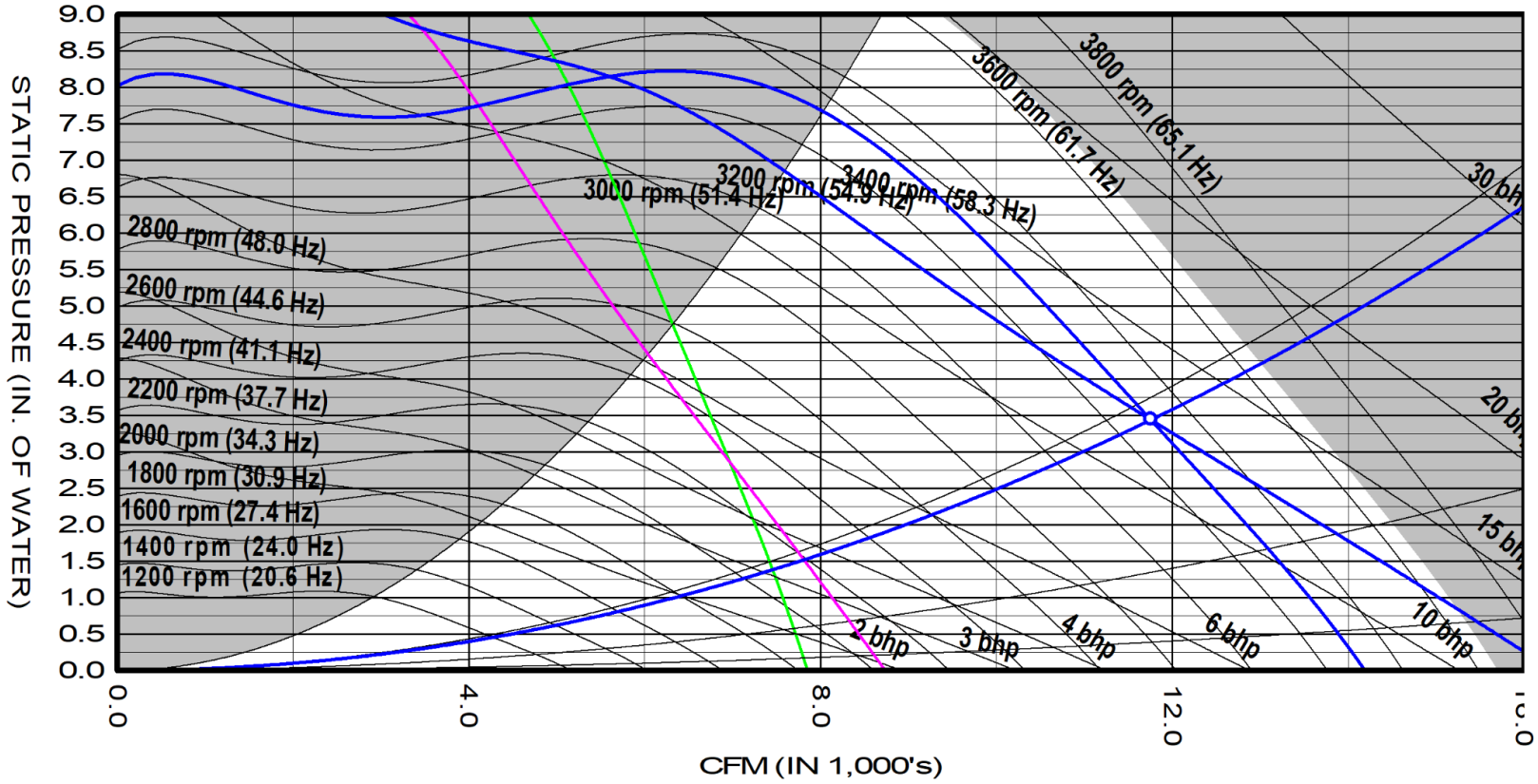
## AHRI Certification

Certified by the AHRI Central Station Air-Handling Unit (AHU) Certification Program, which is based on AHRI Standard 430/431. AHRI certified units are subject to rigorous and continuous testing, have performance ratings independently measured and are third-party verified. Certified units may be found in the AHRI Directory at www.ahridirectory.org.

## Notes

| Standard |
|---|
| 1. As a standalone component, unit meets or exceeds requirements of ASHRAE 90.1 - 2010. The approving authority is responsible for compliance of multi - component building systems. |

## Daikin AHU Fan Curve

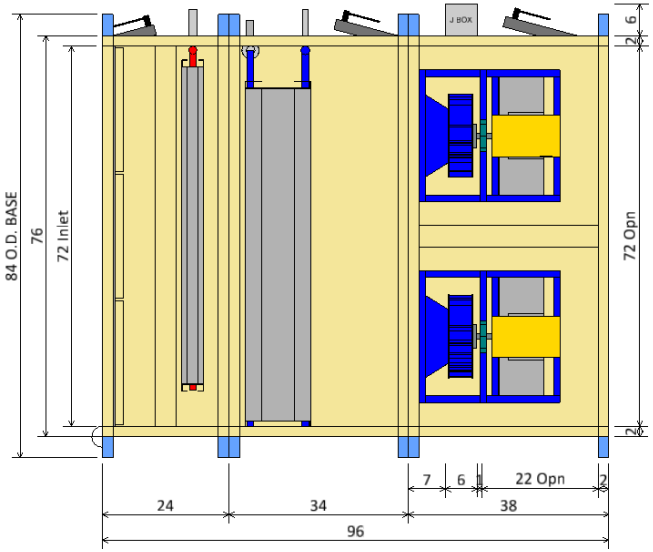



Green line = fan curve for 1 fan(s) at max speed

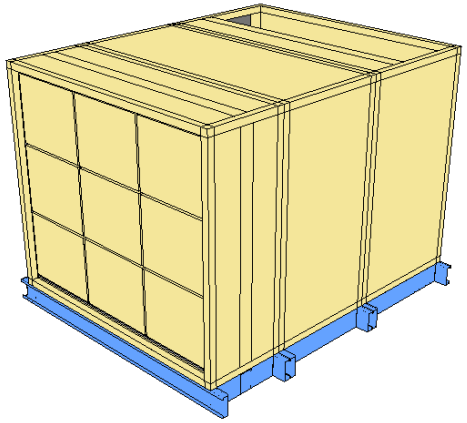
Red line = BHP curve for 1 fan(s) at max power of selected motor

| AF 16 DD PLENUM 9BL (100% Width) 1x2 Supply Fan at Standard Conditions | | | | | |
|---|---|---|---|---|---|
| Air volume | 11760 | cfm | Fan speed | 3299 | rpm |
| Total static | 3.44 | insWg | Max speed | 3650 | rpm |
| Fan Shaft Power | 12.3 | bhp | Efficiency | 51.9 | % |
| Approx VFD Setting | 56.6 | Hz | Motor Speed | 3500 | rpm |
| Fan Energy Index(FEI) | 0.94 | | Redundancy | 63.3 | % |
| Unit tagging | AHU-3 | | Date | May-04-2026 | |
| Job name | 22600705 - DCDSB Archbishop DOC | | Time | 13:06 | |

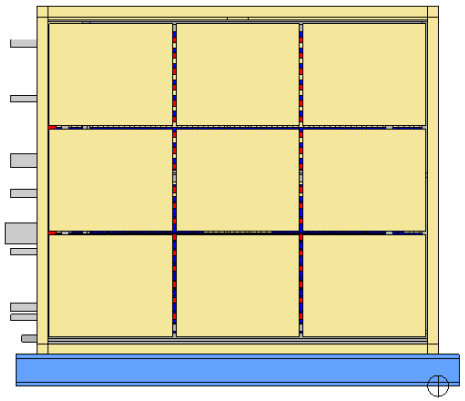
Supply fan performance is certified in accordance with the Central Station Air-Handling Unit Certification Program, which is based on AHRI Standard 430.



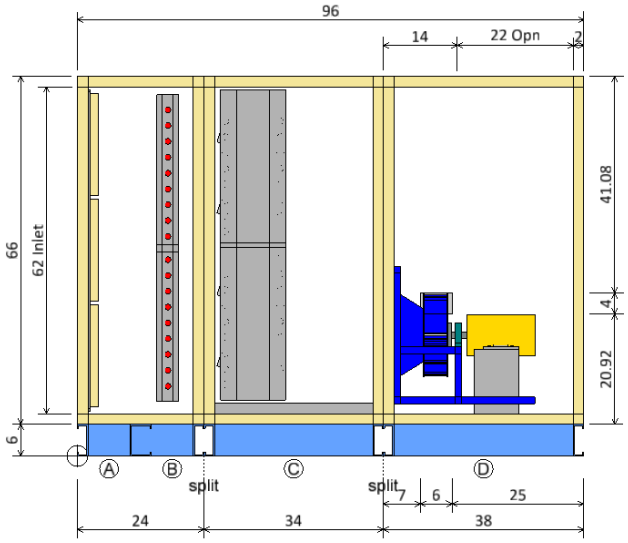

PLAN VIEW



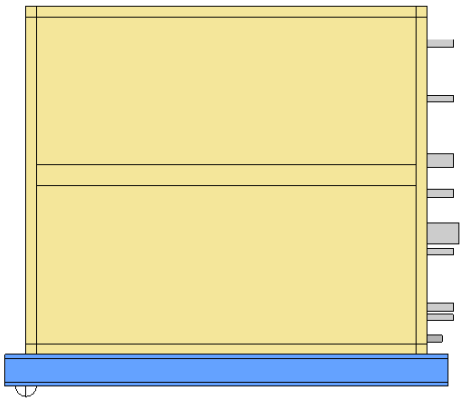
ISOMETRIC VIEW




FRONT END VIEW




ELEVATION VIEW



REAR END VIEW

| | | | | | | |
|---|---|---|---|---|---|---|
| **Plan/Elevation** | Unit Tag: AHU-3 | | | Sales Office: HTS Engineering Ltd. | | |
| Product: Vision Air Handler | Project Name: 22600705 - DCDSB Archbishop DO | | | Sales Engineer: | | |
| Model: CAH025GDGM | May 4, 2026 | Ver/Rev: | Sheet: 1 of 1 | Scale: NTS | Tolerance: +/-0.25" | Dwg Units: in |

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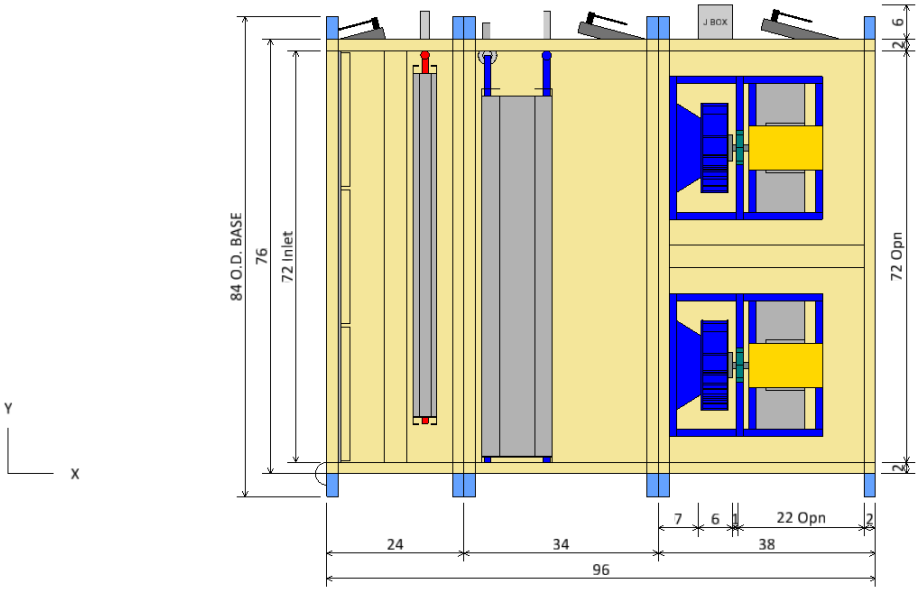
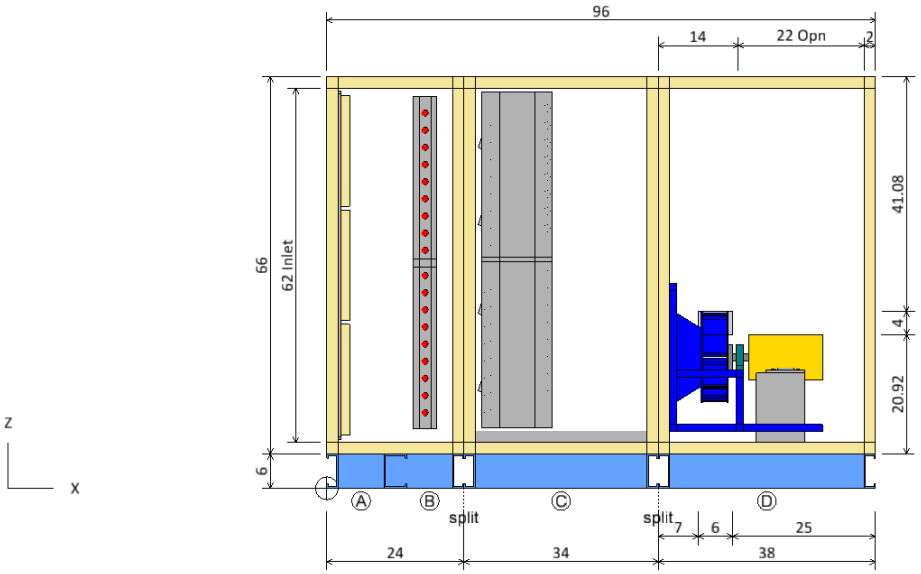
www.DaikinApplied.com Software Version: 13.95

All opening dimensions have a 1" mounting flange along the inner edge. The actual airflow area of the opening is 2" smaller in each dimension.




PLAN VIEW




ELEVATION VIEW

| Component Key | | |
|---|---|---|
| Ⓐ | Panel Filter | |
| | Filter Type: | Pleated (MERV 8) |
| | Left Door (WxH): | 8 ins x 62 ins |
| Ⓑ | Hot Water Coil | |
| | Coil Model: | 5WH0701B |
| | Total Capacity: | 338862.0 Btu/hr |
| Ⓒ | DX Coil | |
| | Coil Model: | 5EJ1008B |
| | Total Capacity: | 587964.0 Btu/hr |
| | Left Door (WxH): | 12 ins x 56 ins |
| Ⓓ | Supply Fan | |
| | Fan Type: | Centrifugal - Plenum |
| | Fan Size (Class): | 16 (2) |
| | Air Flowrate: | 5880.0 cfm |
| | T.S.P: | 3.4 insWg |
| | Motor Power: | 7.5 HP |
| | Left Door (WxH): | 14 ins x 62 ins |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Plan/Elevation - No Ends** | Unit Tag: AHU-3 | | | Sales Office: HTS Engineering Ltd. | | |
| Product: Vision Air Handler | Project Name: 22600705 - DCDSB Archbishop DOC | | | Sales Engineer: | | |
| Model: CAH025GDGM | May 4, 2026 | Ver/Rev: | Sheet: 1 of 1 | Scale: NTS | Tolerance: +/-0.25" | Dwg Units: in |

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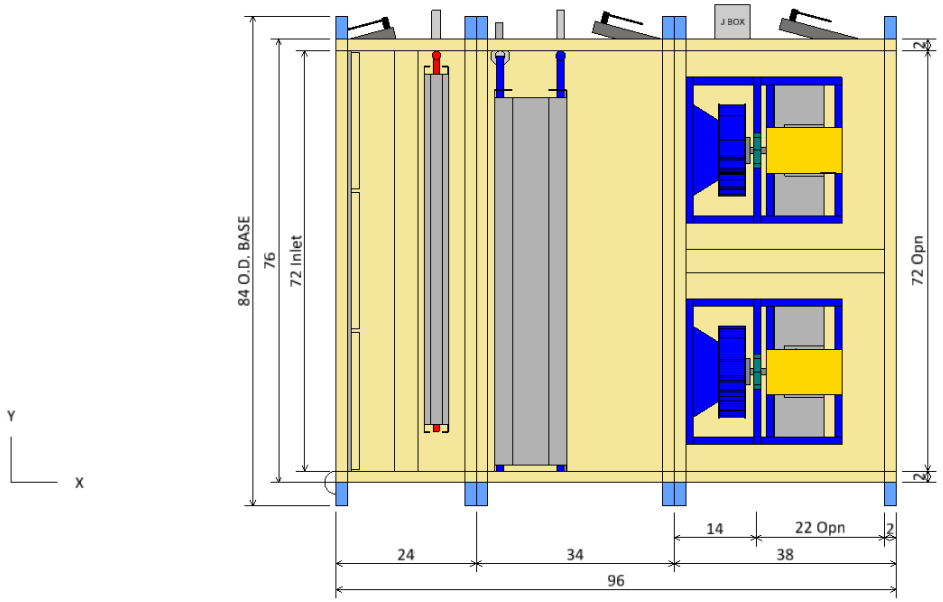
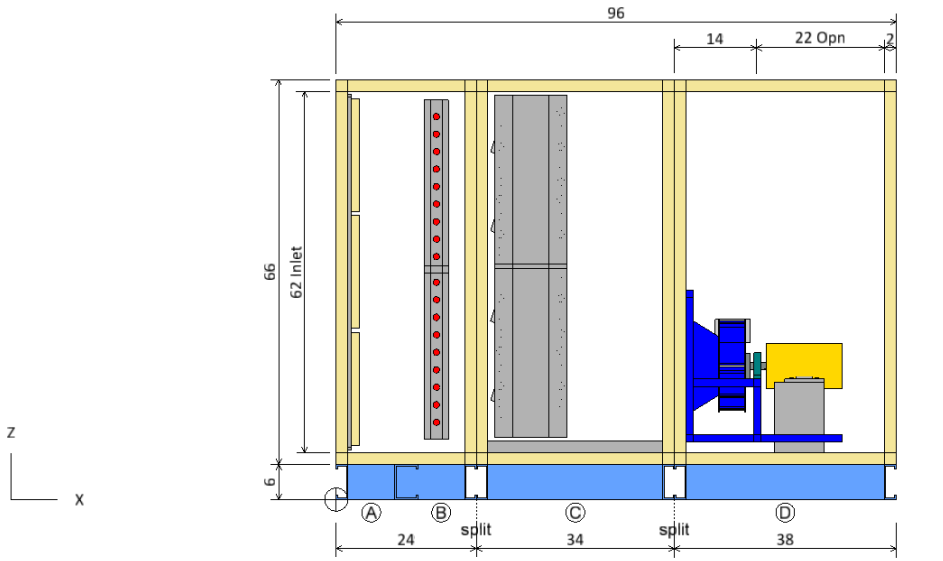
All opening dimensions have a 1" mounting flange along the inner edge. The actual airflow area of the opening is 2" smaller in each dimension.




PLAN VIEW




ELEVATION VIEW

Component Key

| | Type | X | Y | Z | Wid | Hgt |
|---|---|---|---|---|---|---|
| Ⓐ | Panel Filter Opening | 0.00 | 2.00 | 8.00 | 72.00 | 62.00 |
| Ⓓ | Supply Fan Fan Discharge | 72.00 | 2.00 | 72.00 | 72.00 | 22.00 |

Note: Dimensions are measured from the origin point.
Note: Openings with or without dampers are recessed into the unit by approximately 1.75 in.

| | | | | | | |
|---|---|---|---|---|---|---|
| **Opening/Damper Connections** | Unit Tag: AHU-3 | | | Sales Office: HTS Engineering Ltd. | | |
| Product: Vision Air Handler | Project Name: 22600705 - DCDSB Archbishop DOC | | | Sales Engineer: | | |
| Model: CAH025GDGM | May 4, 2026 | Ver/Rev: | Sheet: 1 of 1 | Scale: NTS | Tolerance: +/-0.25" | Dwg Units: in |

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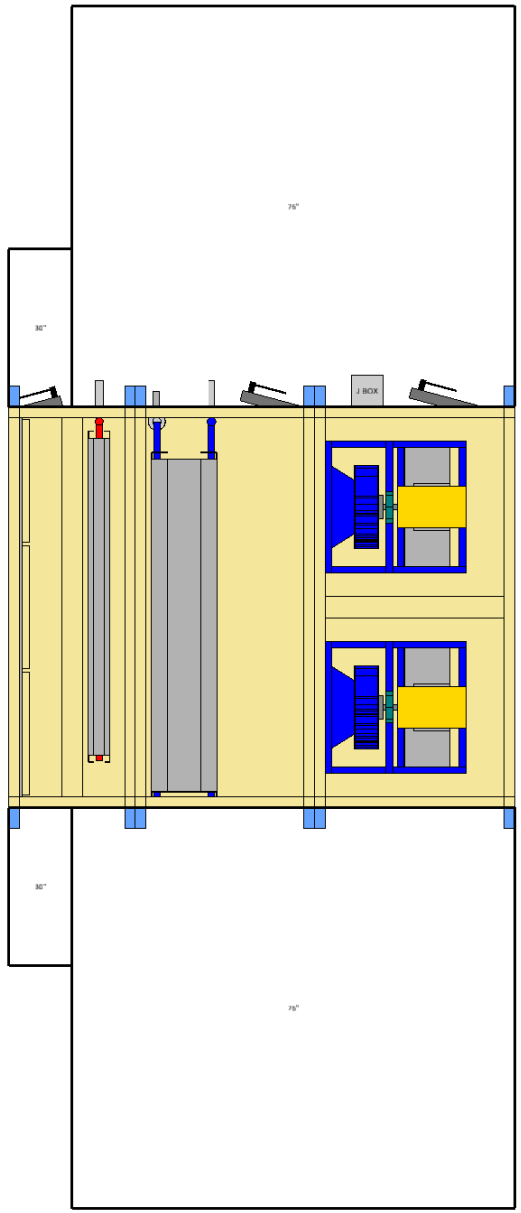


PLAN VIEW

Notes

Check local electrical component service clearance codes for specific distances.

Access is only required on one side of the unit.

| | | | | | | |
|---|---|---|---|---|---|---|
| **Service Clearance View** | Unit Tag: AHU-3 | | | Sales Office: HTS Engineering Ltd. | | |
| Product: Vision Air Handler | Project Name: 22600705 - DCDSB Archbishop DOC | | | Sales Engineer: | | |
| Model: CAH025GDGM | May 4, 2026 | Ver/Rev: | Sheet: 1 of 1 | Scale: NTS | Tolerance: +/-0.25" | Dwg Units: in |

DAIKIN

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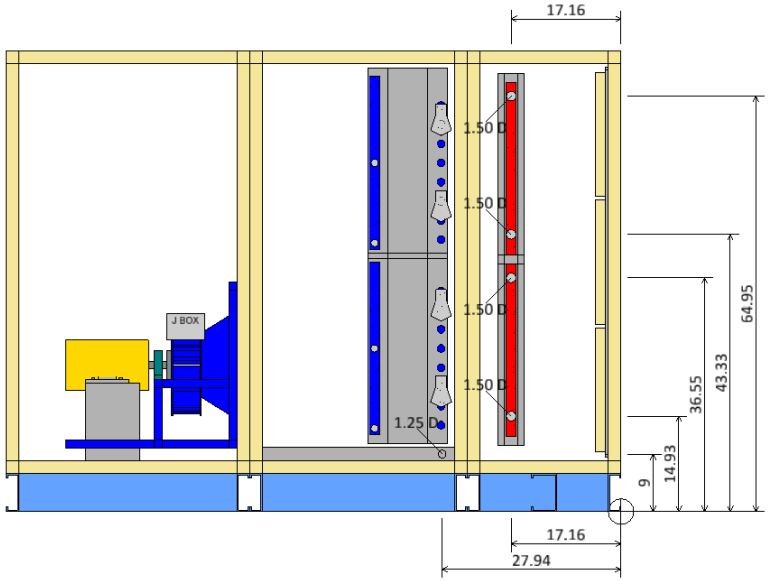
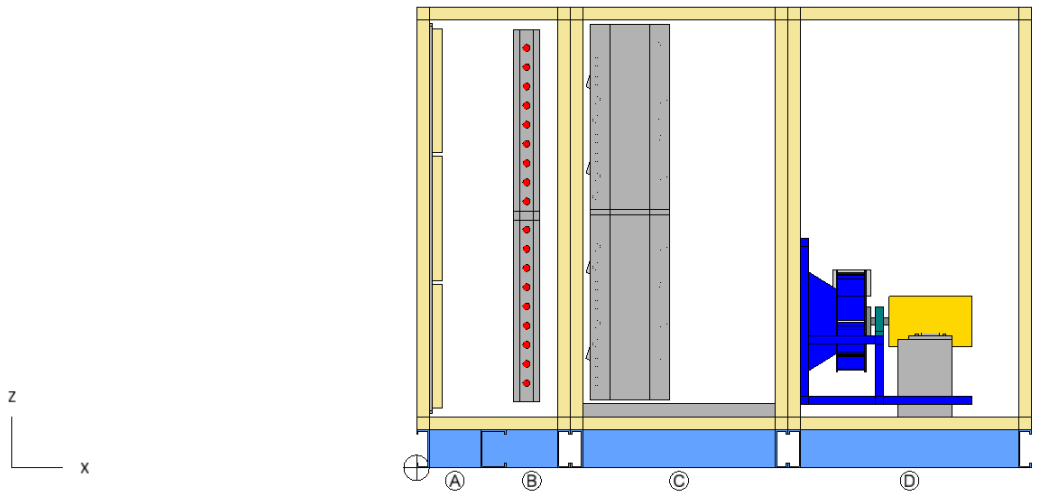



LEFT ELEVATION VIEW




RIGHT ELEVATION VIEW

Coil and Drain Connections

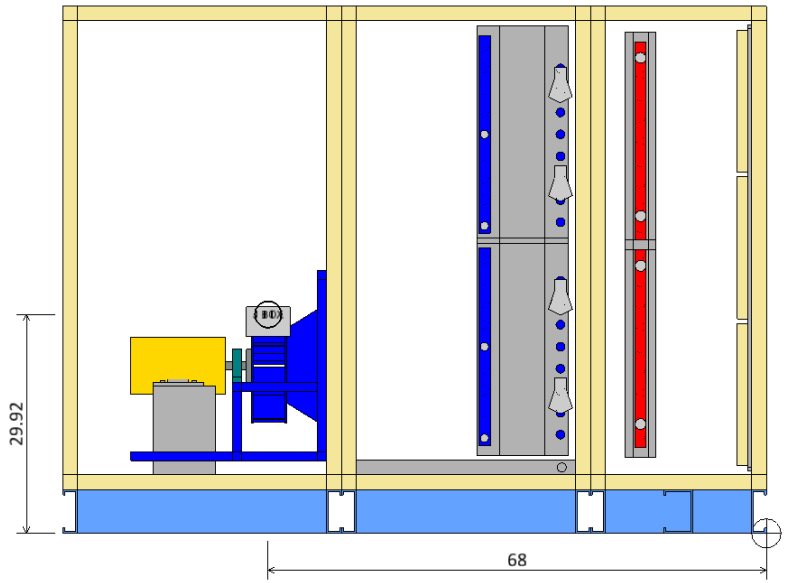
| | Type | X | Y | Z | Diam |
|---|---|---|---|---|---|
| Ⓑ | Hot Water Coil | | | | |
| | Hot water inlet: | 17.16 | 83.00* | 14.93 | 1.50 |
| | Hot water outlet: | 17.16 | 83.00* | 36.55 | 1.50 |
| | Hot water inlet: | 17.16 | 83.00* | 43.33 | 1.50 |
| | Hot water outlet: | 17.16 | 83.00* | 64.95 | 1.50 |
| Ⓒ | DX Coil | | | | |
| | Condensate drain conn: | 27.94 | 78.90 | 9.00 | 1.25 |
| | DX suction: | TBD | TBD | TBD | 2- 1.63 |
| | DX liquid conn: | TBD | TBD | TBD | 2- 1.13 |
| | DX suction: | TBD | TBD | TBD | 2- 1.63 |
| | DX liquid conn: | TBD | TBD | TBD | 2- 1.13 |

Notes:
Dimensions are measured from the origin point.
* value varies +/- 1 in.

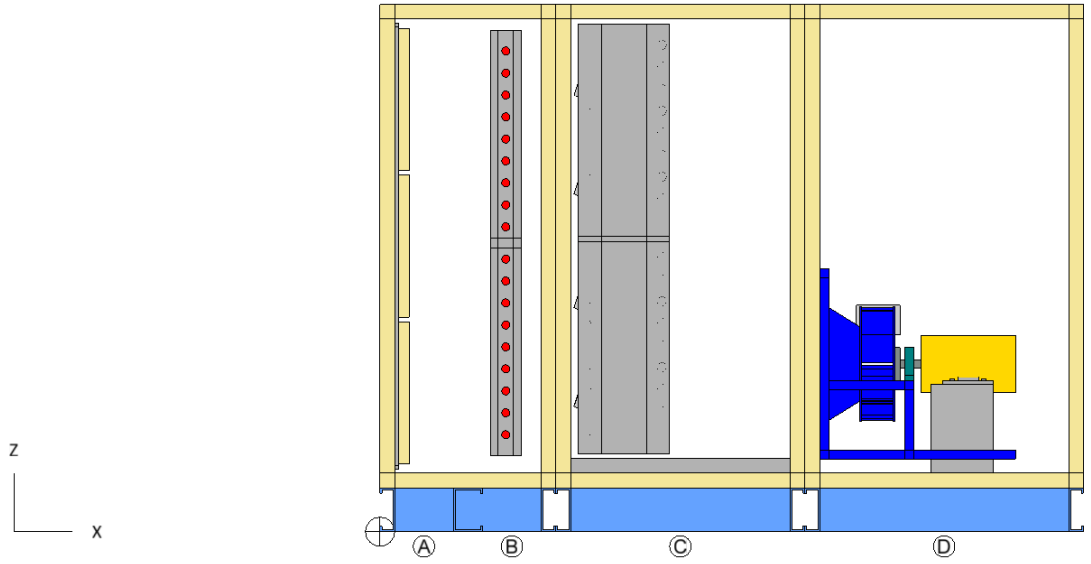
| | | | | | | |
|---|---|---|---|---|---|---|
| **Coil and Drain Connections** | Unit Tag: AHU-3 | | | Sales Office: HTS Engineering Ltd. | | |
| Product: Vision Air Handler | Project Name: 22600705 - DCDSB Archbishop DOC | | | Sales Engineer: | | |
| Model: CAH025GDGM | May 4, 2026 | Ver/Rev: | Sheet: 1 of 1 | Scale: NTS | Tolerance: +/-0.25" | Dwg Units: in |

DAIKIN
13600 Industrial Park Blvd, Minneapolis, MN 55441
www.DaikinApplied.com Software Version: 13.95

All opening dimensions have a 1" mounting flange along the inner edge. The actual airflow area of the opening is 2" smaller in each dimension.




LEFT ELEVATION VIEW




RIGHT ELEVATION VIEW

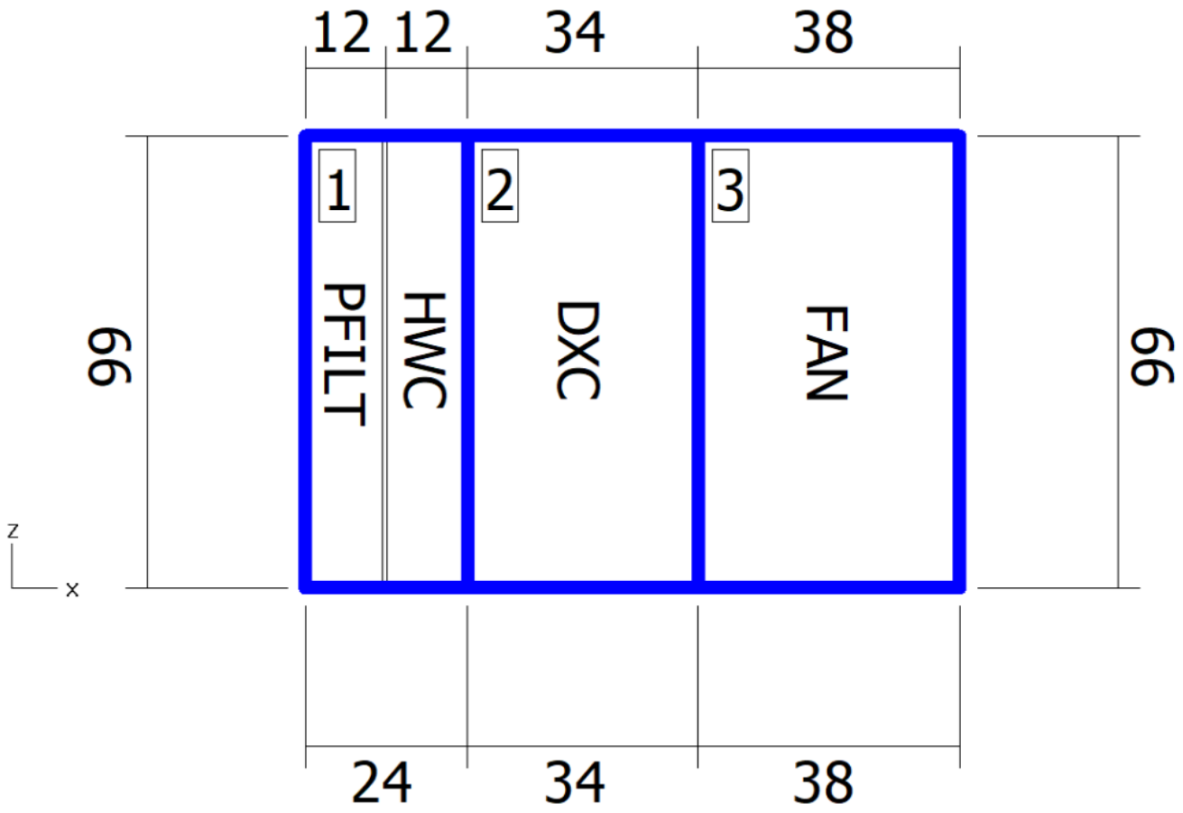
Component Key

| | Type | X | Y | Z | Volts | Phase |
|---|---|---|---|---|---|---|
| Ⓓ | Supply Fan Fan | 68.00 | 76.00 | 29.92 | 575 | 3 |

Note: Dimensions are measured from the origin point.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Electrical Connections** | Unit Tag: AHU-3 | | | Sales Office: HTS Engineering Ltd. | | | DAIKIN |
| Product: Vision Air Handler | Project Name: 22600705 - DCDSB Archbishop DOC | | | Sales Engineer: | | | 13600 Industrial Park Blvd, Minneapolis, MN 55441 |
| Model: CAH025GDGM | May 4, 2026 | Ver/Rev: | Sheet: 1 of 1 | Scale: NTS | Tolerance: +/-0.25" | Dwg Units: in | www.DaikinApplied.com Software Version: 13.95 |

All opening dimensions have a 1" mounting flange along the inner edge. The actual airflow area of the opening is 2" smaller in each dimension.




Elevation View

Shipping Sections

| Section | Weight (lb) | X | Y | Z |
|---|---|---|---|---|
| Section 1 | 719.31 | 24 | 76 | 66 |
| Section 2 | 1314.71 | 34 | 76 | 66 |
| Section 3 | 1163.71 | 38 | 76 | 66 |
| Total Unit | 3197.74 | 96 | 76 | 66 |

Note: Base rails, curb ready base, coil connectors, drain connectors, and control boxes not included in height X, Y, Z dimensions. Shipping section may be 2" longer in air flow direction due to internal splice joint.

| | | | | | | |
|---|---|---|---|---|---|---|
| **Shipping Sections** | Unit Tag: AHU-3 | | | Sales Office: HTS Engineering Ltd. | | |
| Product: Vision Air Handler | Project Name: 22600705 - DCDSB Archbishop DOC | | | Sales Engineer: | | |
| Model: CAH025GDGM | May 4, 2026 | Ver/Rev: | Sheet: 1 of 1 | Scale: NTS | Tolerance: +/-0.25" | Dwg Units: in |

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www.DaikinApplied.com Software Version: 13.95

All opening dimensions have a 1" mounting flange along the inner edge. The actual airflow area of the opening is 2" smaller in each dimension.

Monday, May 4, 2026

# Project Name: DCDSB - Archbishop Denis O'Connor

## VFD Schedule

| Schedule | | | Drive Data | | | |
|---|---|---|---|---|---|---|
| Item | Qty | Tag | Product ID | HP | Amps | Volts |
| 1 | 1 | | ACH580-PDR-017A-6 | 15 | 17 | 600 VAC |

Note: All of the above ABB Variable Frequency Drives are equipped with the following features:

- 5 % Input line Impedance
- Door Interlock Disconnect Switch
- VFD Input Fuses
- BACnet MSTP Protocol
- RFI / EMI Filter
- NEMA 1 Enclosure
- Dual Overloads for dual motor control (installed in an enclosure beneath VFD)
- Two years warranty
- Startup

**Submittal Schedule Details for**

| Item | Tag / Equipment ID | Product ID |
|---|---|---|
| 1 | | ACH580-PDR-017A-6 |

| Item Description |
|---|
| **Input Voltage:** 600 VAC Three Phase<br>**Rated Output Current:** 17A<br>**Enclosure:** UL (NEMA) Type 1<br>**Nominal Horsepower:** 15 HP<br>**Frame Size:** R2<br>**Input Disconnecting Means:** Disconnect with VFD fuses<br>**Bypass:** None<br>**Input Impedance:** 5% equivalent impedance<br>**Short Circuit Current Rating:** 100 kA<br>**Communication Protocols:** Johnson Controls N2, Modbus RTU, BACnet (MS/TP)<br>**Other Options:** |

| Drive Input Fuse Ratings | |
|---|---|
| **Fuse Class** | **Amps (600 V)** |
| Class T | 30 |

| Wire Size Capacities of Power Terminals | | |
|---|---|---|
| **Input Wiring** | **Output Wiring** | **Ground Wiring** |
| #14…#4<br>4.6 lbf-ft | #20…#6<br>1.2 lbf-ft | #14…#2<br>#14…#10: 2.9 lbf-ft; #6…#4: 3.8 lbf-ft; #2: 4.1 lbf-ft |

| Dimensions and Weights | | | |
|---|---|---|---|
| **Height** ***in*** ***(mm)*** | **Width** ***in*** ***(mm)*** | **Depth** ***in*** ***(mm)*** | **Weight** ***lbs*** ***(kg)*** |
| 28.5<br>(725) | 6.3<br>(161) | 12.6<br>(321) | 22<br>(10) |

| Heat Dissipation & Airflow Requirements | | | |
|---|---|---|---|
| **Power Losses** | | **Airflow** | |
| **BTU/Hr** | **Watts** | **CFM** | **CM/Hr** |
| 1,125 | 330 | 25 | 42.5 |

PRODUCT OVERVIEW

# ACH580 Packaged Drives with Disconnect

The ACH580 drive sets new standards in both simplicity and reliability, and ensures smooth, energy-efficient operation of your HVAC systems in normal and mission-critical situations.

The ACH580 Packaged Drive is an ACH580 Variable Frequency Drive enclosed with either an input disconnect switch and fast acting fuses (ACH580-PDR) or an input circuit breaker (ACH580-PCR). The ACH580 Packaged Drive provides a door-mounted input disconnect operator (padlockable in the OFF position), electronic motor overload protection, a door mounted control panel with graphical display for local control, provisions for external control connections, and serial communications capability.

UL (NEMA) Type 1 and 12 Packaged Drive units are available from 1 to 100 HP at 208/230V, 1 to 550 HP at 460V, and 2 to 150 HP at 575V. UL (NEMA) Type 1 and 12 units are wall mounted from 1 to 200 HP and floor mounted from 250 to 550 HP.

For outdoor applications, UL (NEMA) Type 3R Packaged Drive units are available from 1 to 100 HP at 208/230V, 1 to 350 HP at 460V and 2 to 150 HP at 575V. Construction is sheet steel with a tough powder coat paint finish for corrosion resistance. A thermostatically controlled space heater and forced ventilated air cooling system are standard.

**Features for HVAC**

The ACH580 comes standard with an intuitive control panel used to configure, control, and monitor the drive. An optional Bluetooth control panel allows the drive to be configured via the control panel or the DriveTune app.

A robust HVAC firmware package provides drive, motor, and application protection features. Examples of drive protection features include undervoltage, overvoltage, overcurrent, and ground fault protection. The ACH580 also has a variety of motor protection features including overload and stall protections.

Application specific features, such as accepting four separate start interlocks (safeties), along with broken belt detection, are also included. The drive includes BACnet MS/TP, Modbus RTU, and Johnson N2 as standard. Additional protocols, such as BACnet/IP and LonWorks (coming 2019), are available with optional fieldbus adapters.

# Technical specifications

| | |
|---|---|
| **Product compliance (complete list on following page)** | |
| ACH580-PxR | UL508A |
| **Supply connection** | |
| Input voltage ($U_1$)<br>ACH580-xx-xxxA-2<br>ACH580-xx-xxxA-4<br>ACH580-xx-xxxA-6<br>Input voltage tolerance<br>Phase | <br>208/240V<br>480V<br>600V<br>+10% / -15%<br>3-phase (1-phase, 240 V) |
| Frequency | 48 to 63 Hz |
| Line Limitations | Max ±3% of nominal phase to phase input voltage |
| Power Factor (cos φ) at nominal load<br>ACH580-PxR | <br>0.98 |
| Efficiency at rated power<br>ACH580-PxR | <br>98.0% |
| Power Loss | Approximately 2% of rated power |
| **Motor connection** | |
| Supported motor control | Scalar and vector |
| Supported motor types | Asynchronous motor, permanent magnet motor (vector), SynRM (vector) |
| Voltage | 3-phase, from 0 to supply voltage |
| Frequency | 0 to 500 Hz |
| Short Term Overload Capacity Variable Torque | 110% for 1 min/10min |
| Peak Overload Capacity<br>Variable Torque | 1.35 for 2 second<br>(2 sec / 10 min) |
| Switching Frequency | 2, 4, 8 or 12 kHz<br>Automatic fold back in case of overload |
| Acceleration/Deceleration Time | 0 to 1800 s |

Short Circuit Current Rating (SCCR)

| | 240V | 480V | 600V |
|---|---|---|---|
| **-PCR** | 100kA | 100kA | ≤60 Hp: 25 kA<br>≥75 Hp: 10 kA |
| **-PDR** | 100kA | 100kA | 100kA |

# Technical specifications

| **Inputs and outputs (drive)** | |
|---|---|
| 2 analog inputs | Selection of Current/Voltage input mode is user programmable. |
| Voltage reference | 0 (2) to 10 V, $R_{in}$ > 200 kΩ |
| Current reference | 0 (4) to 20 mA, $R_{in}$ = 100 Ω |
| Potentiometer reference value | 10 V ±1% max. 20 mA |
| 2 analog outputs | AO1 is user programmable<br>for current or voltage.<br>AO2 current |
| Voltage reference | 0 to 10 V, $R_{load}$: > 100 kΩ |
| Current reference | 0 to 20 mA, $R_{load}$: < 500 Ω |
| Applicable potentiometer | 1 kΩ to 10 kΩ |
| Internal auxiliary voltage | 24 V DC ±10%, max. 250 mA |
| Accuracy | +/- 1% full scale range at 25°C (77°F) |
| Output updating time | 2 ms |
| 6 digital inputs | 12 to 24 V DC, 10 to 24 V AC,<br>Connectivity of PTC sensors supported by a single digital input.<br>PNP or NPN connection<br>(5 DIs with NPN connection).<br>Programmable |
| Input Updating Time | 2 ms |
| 3 relay outputs | Maximum switching voltage<br>250 V AC/30 V DC.<br>Maximum continuous current 2 A rms.<br>Programmable, Form C |
| Contact material | Silver Tin Oxide ($AgSnO_2$) |
| PTC, PT100 and PT1000 | Any of the analog inputs, or digital input 6, are configurable for<br>PTC with up to 6 sensors. |
| Adjustable filters on analog inputs and outputs | |
| All control inputs isolated from ground and power | |
| **Operation** | |
| Air temperature | 0 to -15 °C (32 to 5 °F).<br>-15 to +50 °C (5 to 122 °F):<br>No frost allowed.<br>Output derated above +40 °C (104 °F) |
| Installation site altitude | 0 to 1000 m (3281 ft)<br>above sea level<br>Output derated above 1000 m (3281 ft) |
| Relative humidity | 5 to 95%<br>No condensation allowed<br>Maximum relative humidity is 60% in the presence of corrosive gasses |
| Atmospheric pressure | 70 to 106 kPa (10.2 to 15.4 PSI)<br>0.7 to 1.05 atmospheres |
| Siesmic | Risk category IV Certified (IBC 2018) |

# Feature overview

**Communication**
Protocols as standard (EIA-485): BACnet MS/TP, Modbus RTU, Johnson Controls N2
Available as plug-in options: BACnet/IP, Modbus TCP, PROFIBUS-DP, DeviceNet, EtherNet/IP

**Application functions**
Start interlock
Delayed start
Run permissive (damper monitoring)
Override operation mode
Real-time clock (scheduling)
PID controllers for motor and process
Motor flying start
Motor preheating
Energy optimizer and calculators
Timer
2 or 3 wire start/stop
Ramp to stop
2 independent adjustable accel/decel ramp

**Protection functions**
Overvoltage controller
Undervoltage controller
Motor earth-leakage monitoring
Motor short-circuit protection
Motor overtemperature protection
Output and input switch supervision
Motor overload protection (UL508C)
Phase-loss detection (both motor and supply)
Under load supervision (belt loss detection)
Overload supervision
Stall protection
Loss of reference
Panel loss
Ground fault
External events
Overcurrent
Current limit regulator
Transient/Surge protection (MOV and choke)

**Panel functions**
First start assistant
Primary settings for HVAC applications
Hand-Off-Auto operation mode
HVAC quick set-up
Includes Day, Date and Time
Operator Panel Parameter Backup (read/write)

Full Graphic and Multilingual Display for Operator Control, Parameter Set-Up and Operating Data Display:
- Output Frequency (Hz)
- Speed (RPM)
- Motor Current
- Calculated % Motor Torque
- Calculated Motor Power (kW)
- DC Bus Voltage
- Output Voltage
- Heatsink Temperature
- Elapsed Time Meter (resettable)
- kWh (resettable)
- Input / Output Terminal Monitor
- PID Actual Value (Feedback) & Error Fault Text
- Warning Text
- Three (3) Scalable Process Variable Displays
- User-Definable Engineering Units

**Motor control features**
Scalar (V/Hz) and vector modes of motor control
V/Hz shapes
- Linear
- Squared

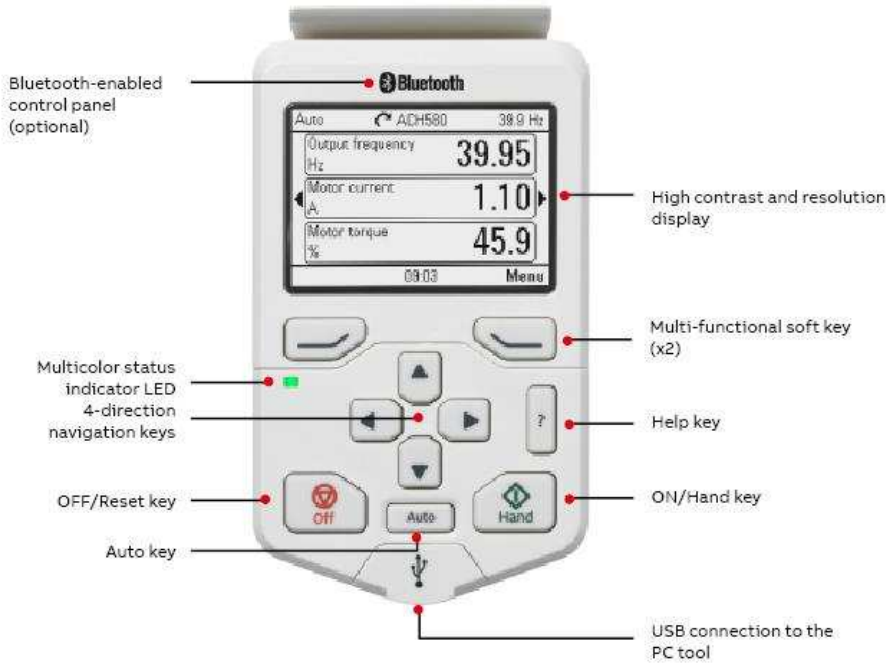
Energy optimization
IR compensation
Slip compensation
Three (3) Critical Frequency Lockout Bands

**PID control**
One (1) Process PID
Four (4) Integral Independent Programmable PID Setpoint Controllers (Process and External)
External Selection between Two (2) Sets of Process PID Controller Parameters
PID Sleep/Wake-Up

# Control panel features

The ACH580 Assistant Control Panel features:

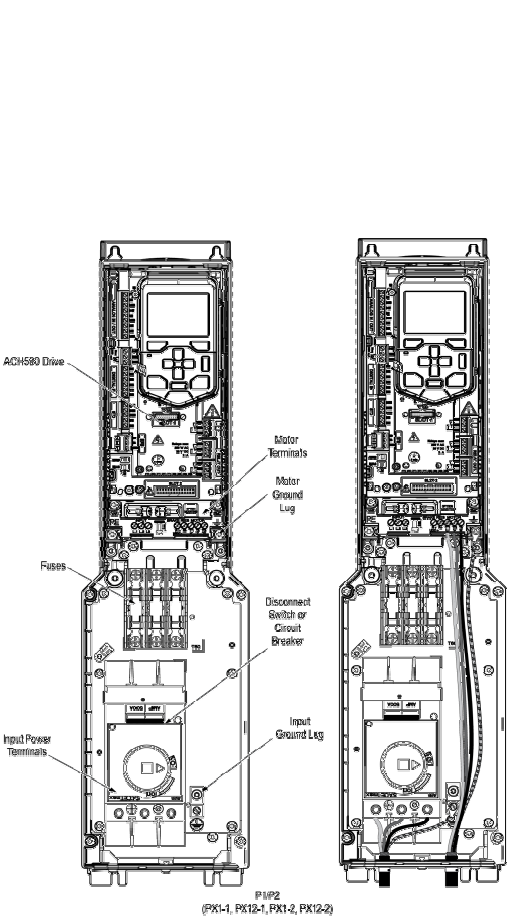
- Intuitive to operate
- Primary Setting menu to ease drive commissioning
- Real-time clock
- Diagnostic and maintenance functions
- Full-graphic display, including chart, graph, and meter options
- 21 editable home views
- USB interface for PC and tool connection as standard
- Parameters are alpha-numeric
- North American version supports 14 languages as standard
- Dedicated “Help” key
- 4 user sets
- Parameter are stored in control panel memory for later transfer to other drives or for backup of a particular system
- Back-up and restore parameters and/or motor data
- Automatic back-up 2 hours after parameter change
- Modified parameter display
- Creates unique short menu
- Shows parameters that differ from the default
- Bluetooth connectivity for use with mobile device (requires +J429 option)



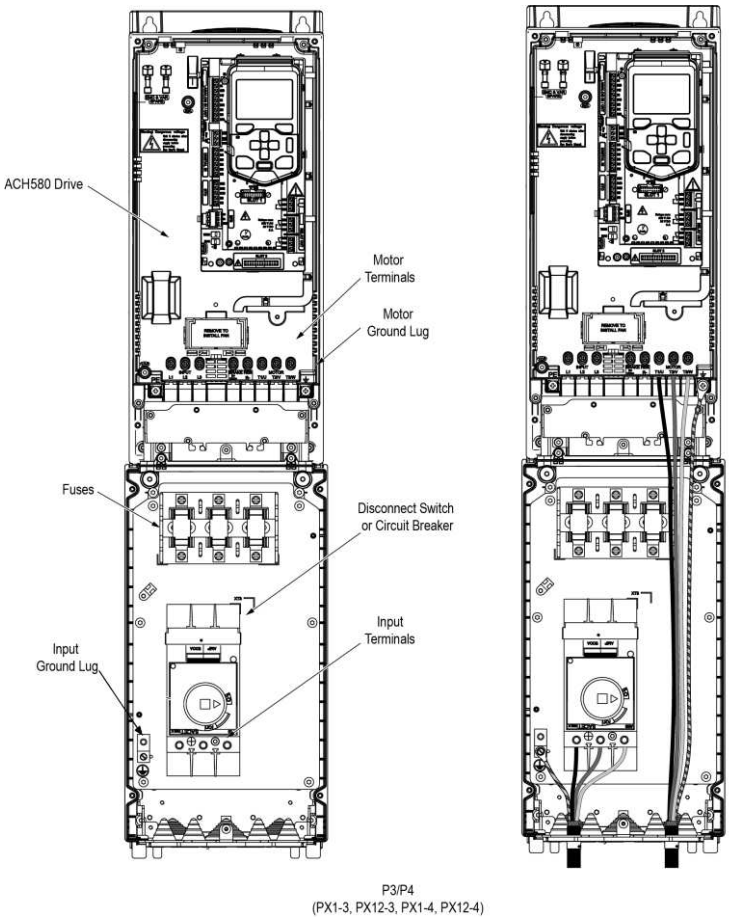
# Cable connections

The following illustrations show the ACH580 Packaged Drive cable connection points for the various enclosure styles. The illustrations indicate the location of input and output power connections as well as equipment and motor grounding connection points.

ACH580-PCR and PDR packages are configured for wiring access from the bottom only on vertical wall mount units and from the top only on UL (NEMA) Type 1 and 12 standard wall mount units. UL (NEMA) Type 3R enclosures are configured for bottom access. At least three separate metallic conduits are required, one for input power, one for output power to the motor and one for control signals.

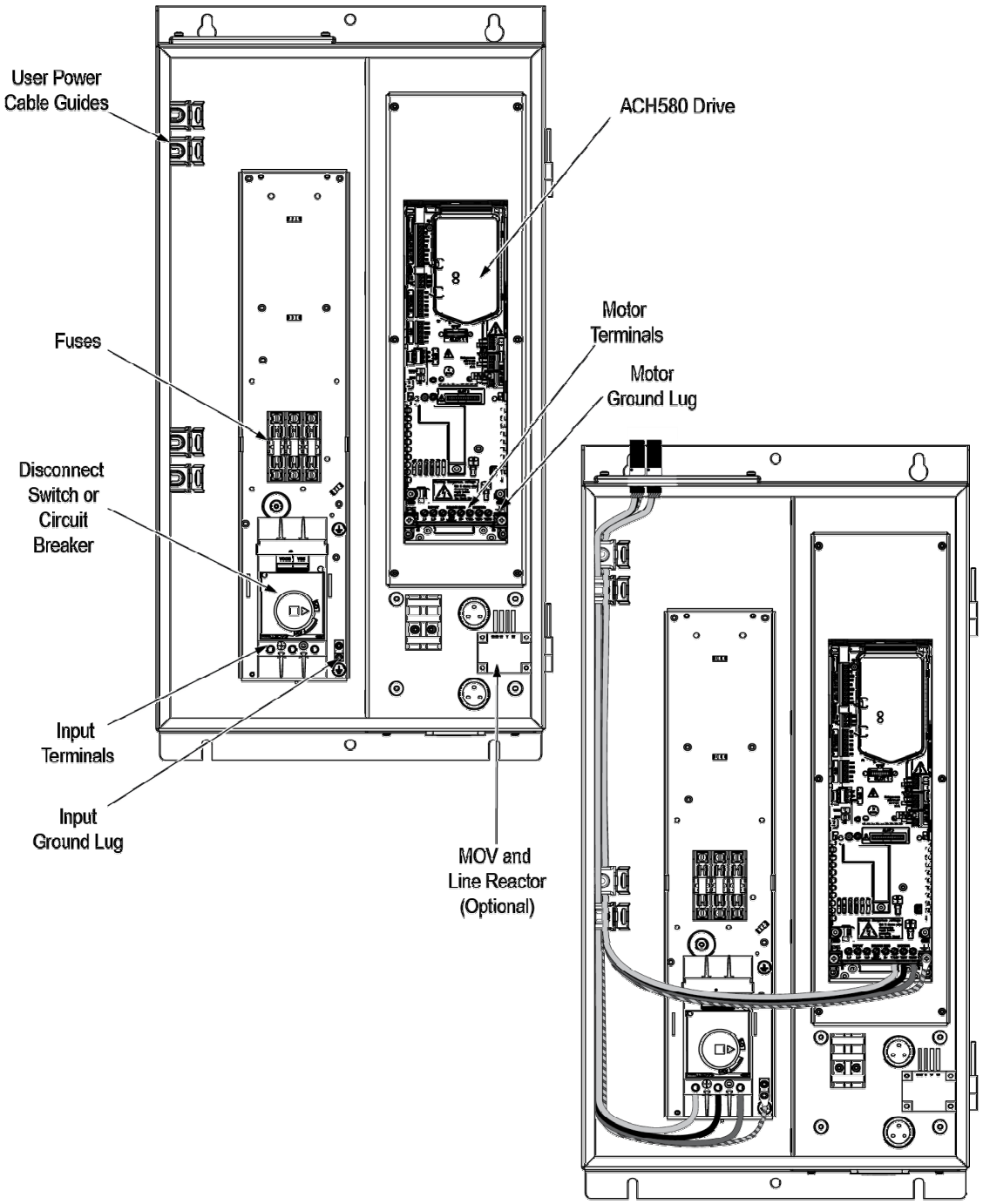



P1/P2
(PX1-1, PX12-1, PX1-2, PX12-2)



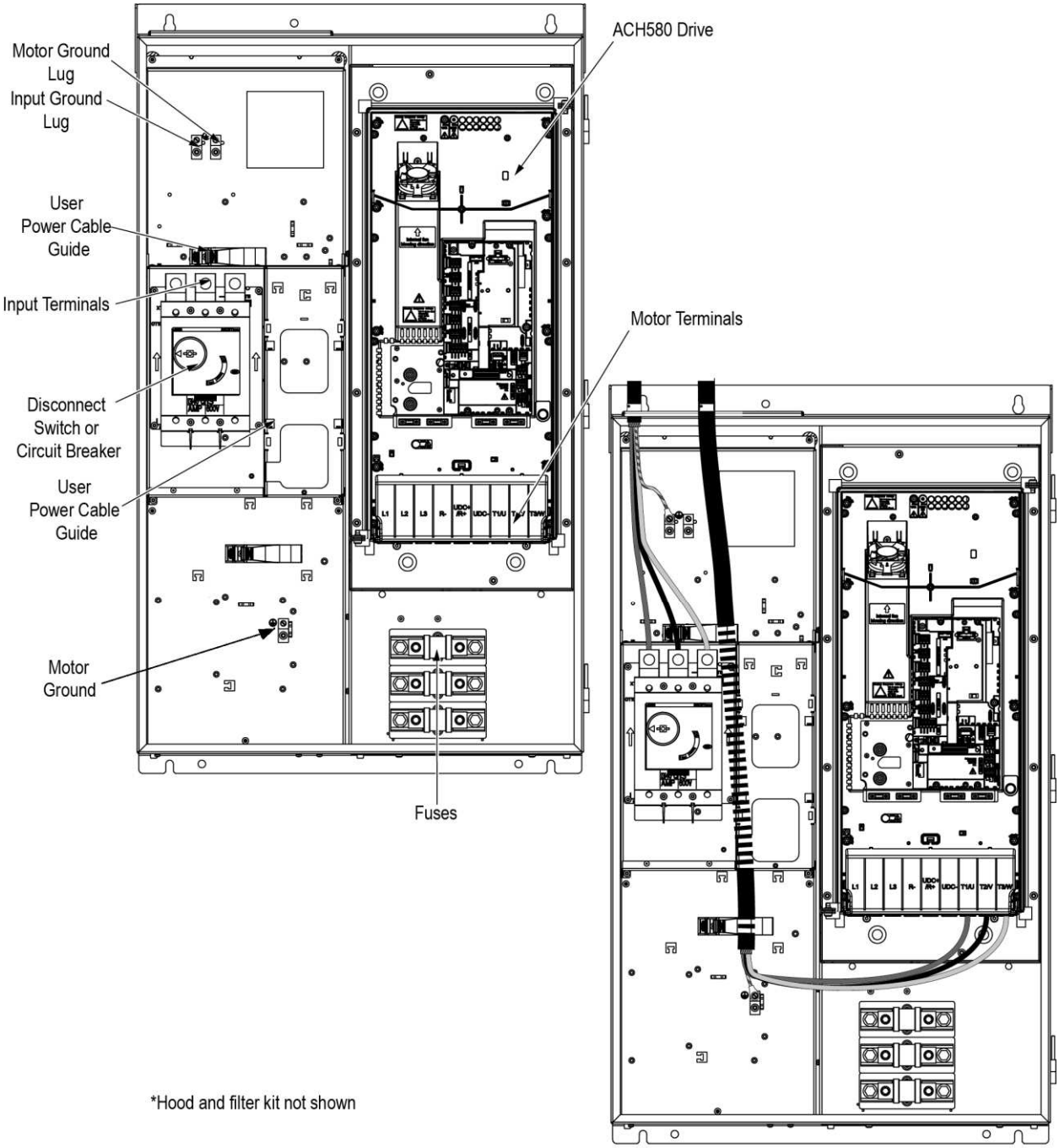

P3/P4
(PX1-3, PX12-3, PX1-4, PX12-4)

# Cable connections




P1/P2
(PX1-1, PX12-1, PX1-2, PX12-2)

# Control connections



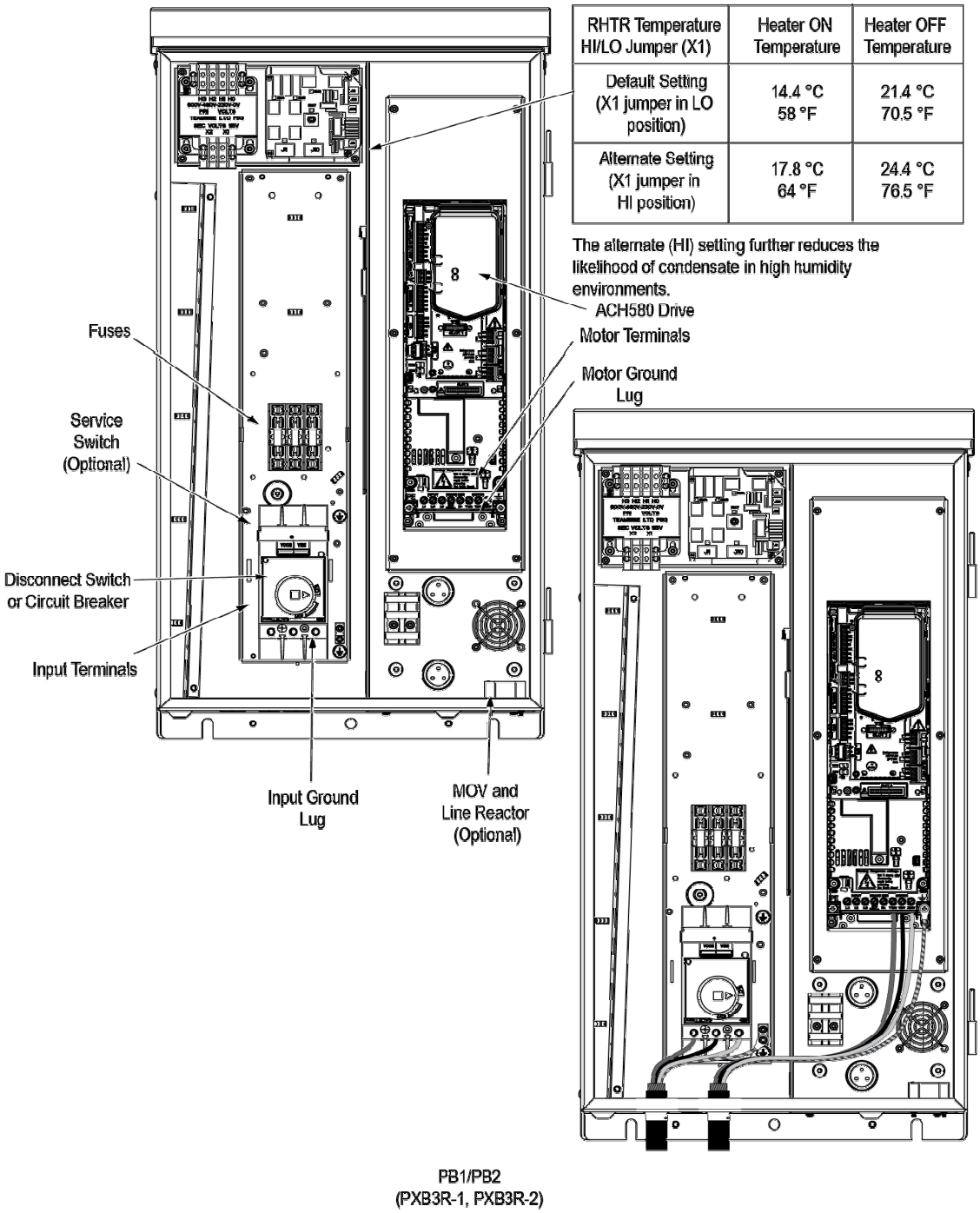

PB3
(PXB1-3, PXB12-3*)

12433592

# Cable connections

| RHTR Temperature HI/LO Jumper (X1) | Heater ON Temperature | Heater OFF Temperature |
|---|---|---|
| Default Setting (X1 jumper in LO position) | 14.4 °C 58 °F | 21.4 °C 70.5 °F |
| Alternate Setting (X1 jumper in HI position) | 17.8 °C 64 °F | 24.4 °C 76.5 °F |

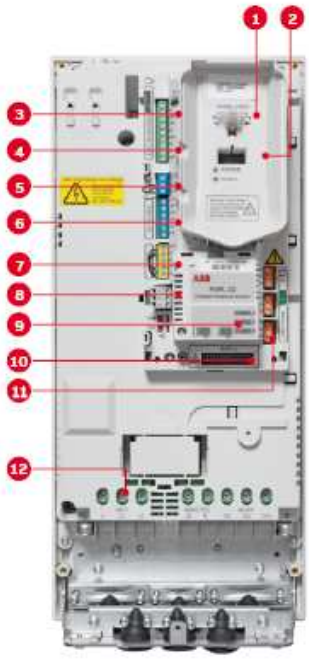
The alternate (HI) setting further reduces the likelihood of condensate in high humidity environments.



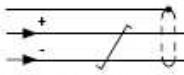

PB1/PB2
(PXB3R-1, PXB3R-2)

# Control connections

## Default control connections




1. Panel port (PC tools, control panel)
2. ABB drive customizer port for programming the drive without mains
3. Analog inputs (2 × AI)
4. Analog outputs (2 × AO)
5. 24 V DC output
6. Digital inputs (6 × DI)
7. Safe torque off (STO)
8. Embedded fieldbus
9. Communication options (fieldbuses)
10. Analog and digital I/O extensions
11. Relay outputs (3 × RO)
12. Mains connection




0...10 V DC speed reference signal

| Terminal | Meaning | Default macro connections |
|---|---|---|
| **X1** | **Reference voltage and analog inputs and outputs** | |
| 1 | SCR | Signal cable shield (screen) |
| 2 | AI1 | **Output frequency/speed reference:** 0 to 10 V |
| 3 | AGND | Analog input circuit common |
| 4 | +10 V | Reference voltage 10 V DC |
| 5 | AI2 | **Actual feedback:** 0 to 20 mA |
| 6 | AGND | Analog input circuit common |
| 7 | AO1 | **Output frequency:** 0 to 10 V |
| 8 | AO2 | **Motor current:** 0 to 20 mA |
| 9 | AGND | Analog output circuit common |
| **X2 & X3** | **Aux. voltage output and programmable digital inputs** | |
| 10 | +24 V | Aux. voltage output +24 V DC, max. 250 mA |
| 11 | DGND | Aux. voltage output common |
| 12 | DCOM | Digital input common for all |
| 13 | DI1 | **Stop (0)/Start (1)** |
| 14 | DI2 | Not configured |
| 15 | DI3 | **Constant frequency/speed selection** |
| 16 | DI4 | **Start interlock 1 (1 = allow start)** |
| 17 | DI5 | Not configured |
| 18 | DI6 | Not configured |
| **X6, X7, X8** | **Relay outputs** | |
| 19 | RO1C | **Damper control** 250 V AC/30 V DC 2 A — Energize damper 19 connected to 21 |
| 20 | RO1A | |
| 21 | RO1B | |
| 22 | RO2C | **Running** 250 V AC/30 V DC 2 A — Running 22 connected to 24 |
| 23 | RO2A | |
| 24 | RO2B | |
| 25 | RO3C | **Fault (-1)** 250 V AC/30 V DC 2 A — Fault condition 25 connected to 26 |
| 26 | RO3A | |
| 27 | RO3B | |
| **X5** | **Embedded fieldbus** | |
| 29 | B+ | Embedded fieldbus, EFB (EIA-485) |
| 30 | A- | |
| 31 | DGND | |
| S4 | TERM | Termination switch |
| S5 | BIAS | Bias resistors switch |
| **X4** | **Safe torque off** | |
| 34 | OUT1 | Safe torque off. Factory connection. Both circuits must be closed for the drive to start. See chapter *The Safe torque off function* in the *hardware manual* of the drive. |
| 35 | OUT2 | |
| 36 | SGND | |
| 37 | IN1 | |
| 38 | IN2 | |
| **X10** | **24 V AC/DC** | |
| 40 | 24 V AC/DC+ in | R6-R11 only: Ext. 24V AC/DC input to power up the control unit when the main supply is disconnected. |
| 41 | 24 V AC/DC- in | |

Damper actuator

Run status

Fault status

**Notes:**
- Connected with jumpers at the factory.
- Only frames R6-R11 have terminals 40 and 41 for external 24 V AC/DC input.

# Engineering Data Summary

## *Fuses*

Drive input fuses are recommended to disconnect the drive from power in the event that a component fails in the drive's power circuitry. Recommended drive input fuse specifications are listed in the *Submittal Schedule Details* and in the *Fuse Ratings* Table. Fuse rating information is provided for customer reference.

| Item | Catalog Number | Drive Input Fuse Ratings | |
|---|---|---|---|
| | | Amps (600V) | Bussmann Type |
| 1 | ACH580-PDR-017A-6 | 30 | Class T |

## *Terminal Sizes / Cable Connection Requirements*

Power and motor cable terminal sizes and connection requirements are shown in the *Submittal Schedule Details* and in the *Terminal Sizes / Cable Connection Requirements* Table. The information provided below is for connections to input power and motor cables. These connections may be made to an input circuit breaker or disconnect switch, a motor terminal block, overload relay, and/or directly to bus bars and ground lugs. The table also lists torque that should be applied when tightening terminals and spacing requirements where multiple mounting holes are provided in the bus bar.

| Item | Catalog Number | Input Wiring | Output Wiring | Ground Wiring |
|---|---|---|---|---|
| 1 | ACH580-PDR-017A-6 | #14…#4<br>4.6 lbf-ft | #20…#6<br>1.2 lbf-ft | #14…#2<br>#14…#10: 2.9 lbf-ft; #6…#4: 3.8 lbf-ft; #2: 4.1 lbf-ft |

## *Heat Dissipation Requirements*

The cooling air entering the drive must be clean and free from corrosive materials. The *Submittal Schedule Details* and the *Heat Dissipation Requirements* table below give the heat dissipated into the hot air exhausted from the drives. If the drives are installed in a confined space, the heat must be removed from the area by ventilation or air conditioning equipment.

| Item | Catalog Number | Watts | BTU/Hr |
|---|---|---|---|
| 1 | ACH580-PDR-017A-6 | 330 | 1,125 |

## *Dimensions and Weights*

Dimensions and weights of the drives provided are given in the *Submittal Schedule Details* and in the *Dimensions and Weights* Table. The table also lists the applicable dimension drawings that include additional detail. Dimension drawings may be provided in the back of this submittal.

| Item | Catalog Number | Height *mm (in)* | Width *mm (in)* | Depth *mm (in)* | Weight *kg (lbs)* |
|---|---|---|---|---|---|
| 1 | ACH580-PDR-017A-6 | 725 (28.5) | 161 (6.3) | 321 (12.6) | 10 (22) |

## *Free Space Requirements, Standalone*

Free Space Requirements for standalone mounting.

| Item | Catalog Number | Standalone, Above *mm (in)* | Standalone, Below *mm (in)* | Standalone, Sides *mm (in)* |
|---|---|---|---|---|
| 1 | ACH580-PDR-017A-6 | 150 (5.9) | 86 (3.4) | 150 (5.9) |

## *Free Space Requirements, Side by Side*

Free Space Requirements for side by side mounting.

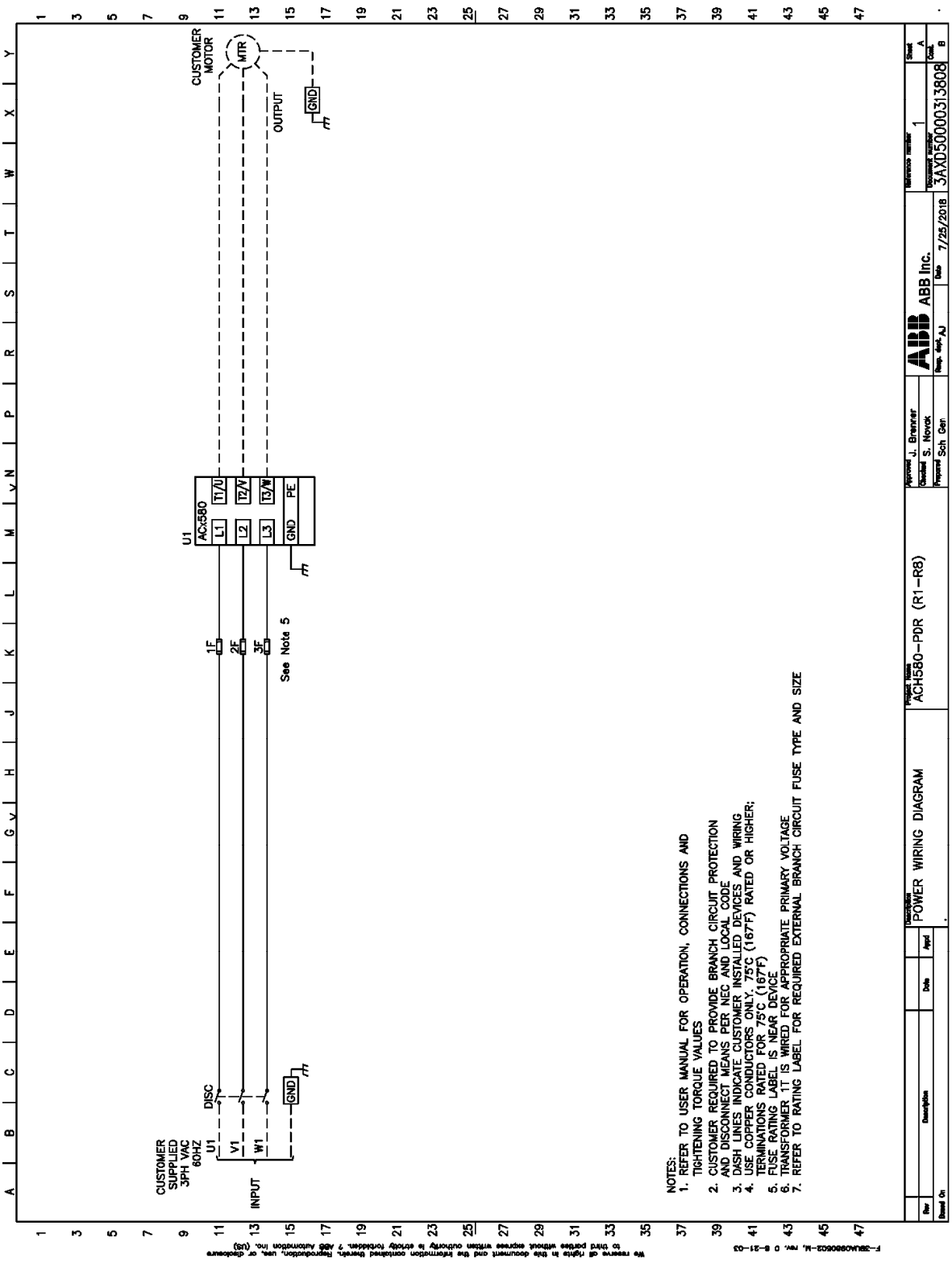
| Item | Catalog Number | Side by Side, Above *mm (in)* | Side by Side, Below *mm (in)* | Side by Side, Sides *mm (in)* |
|---|---|---|---|---|
| 1 | ACH580-PDR-017A-6 | 200 (7.9) | 200 (7.9) | 0 (0.0) |

## *Product short Circuit Current Rating*

Short circuit ratings shown below are as show on the device rating label.

| Item | Catalog Number | Short Circuit Current Rating |
|---|---|---|
| 1 | ACH580-PDR-017A-6 | 100 kA |

| Item | Part Number | Customer Designation |
|---|---|---|
| 1 | ACH580-PDR-017A-6 | |



{3AXD50000313808_1.png}

| Item | Part Number | Customer Designation |
|---|---|---|
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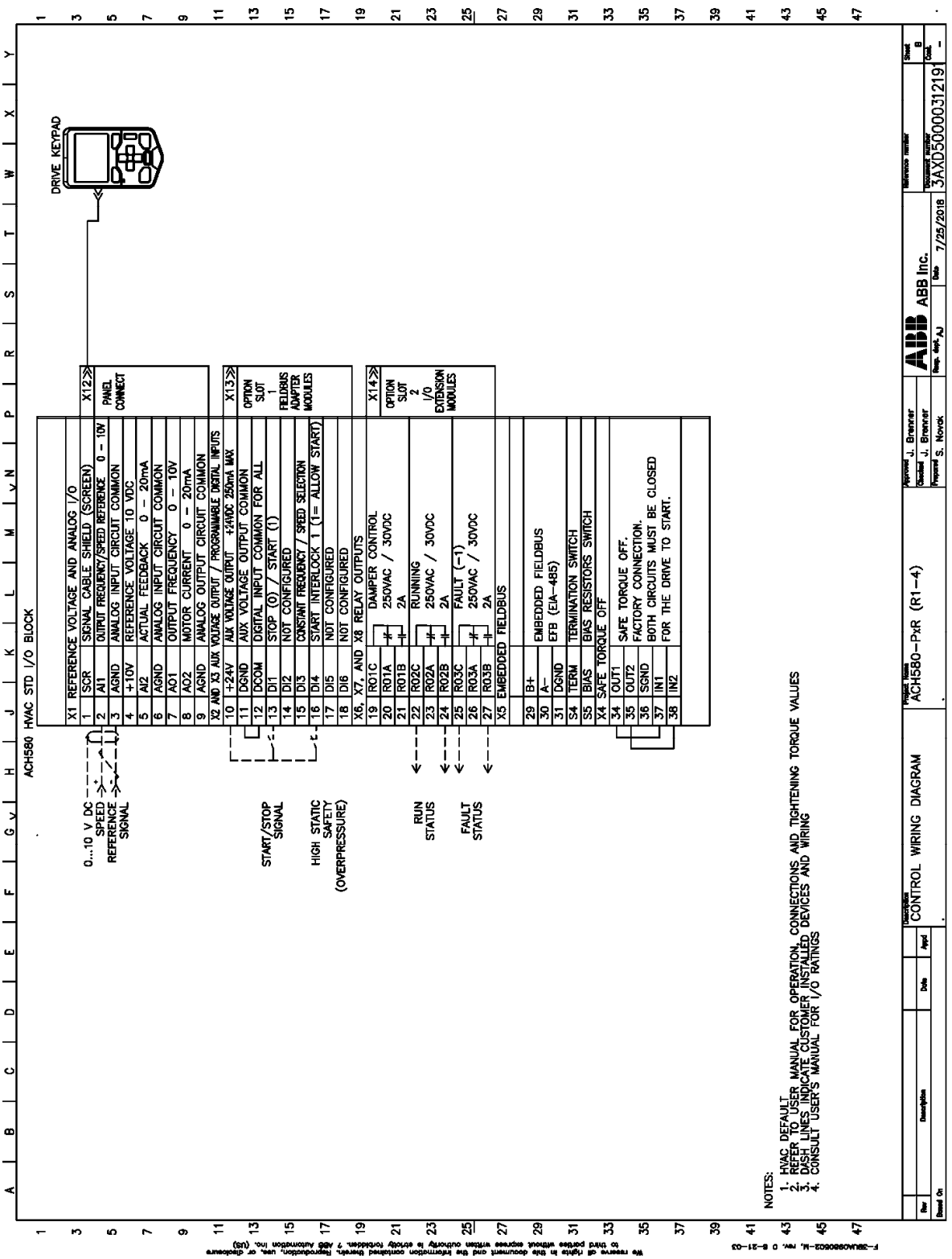
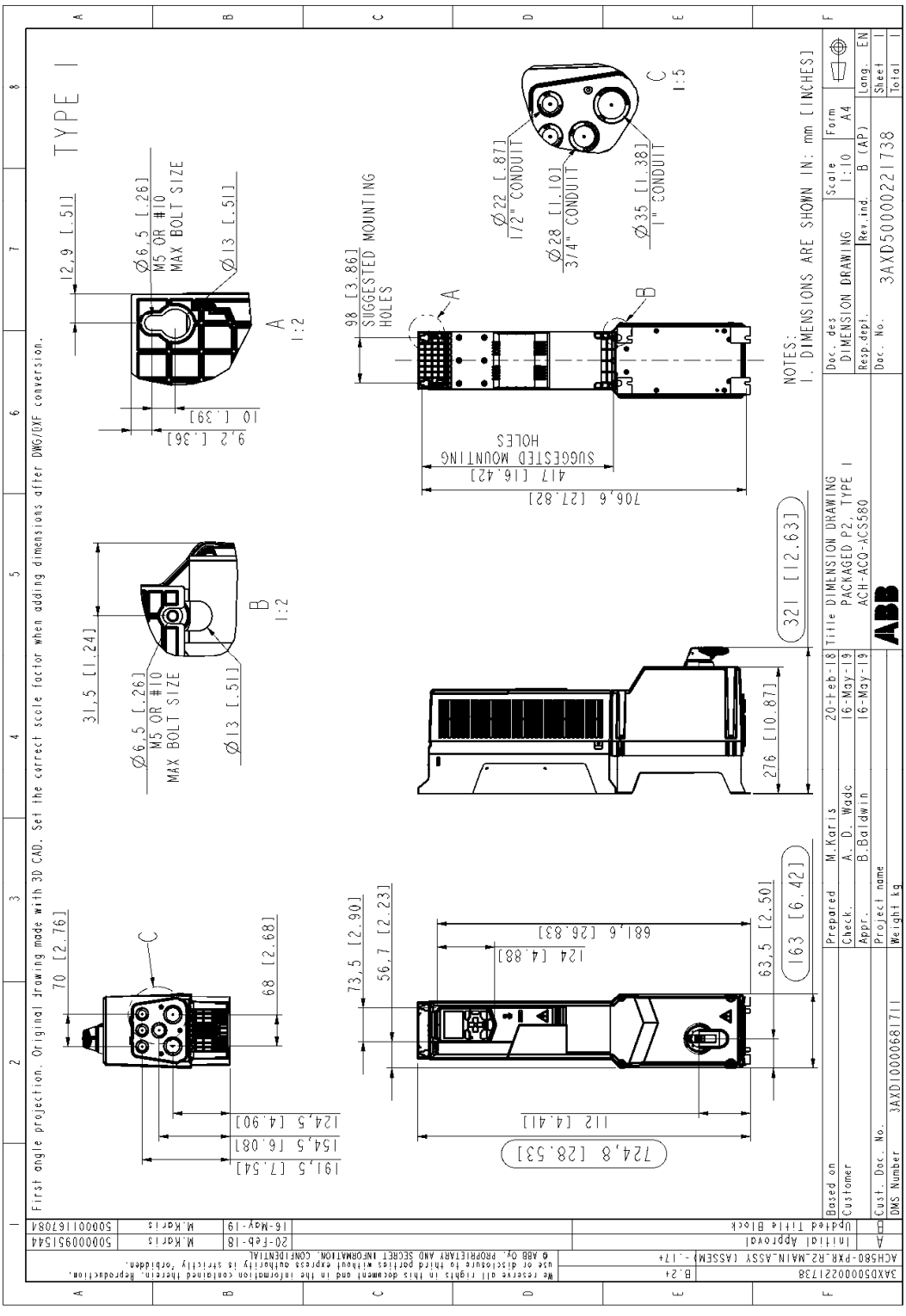
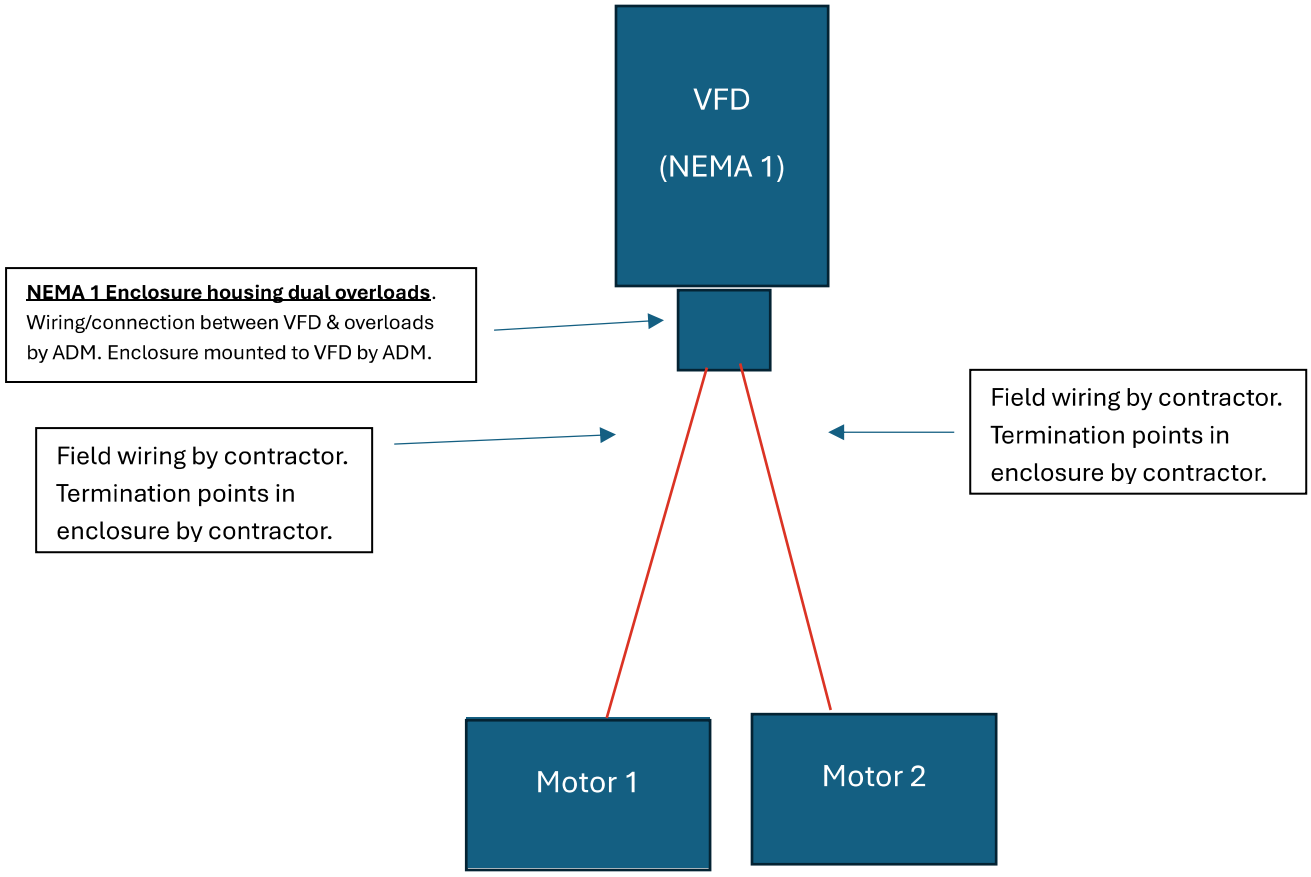


{3AXD50000312191.png}

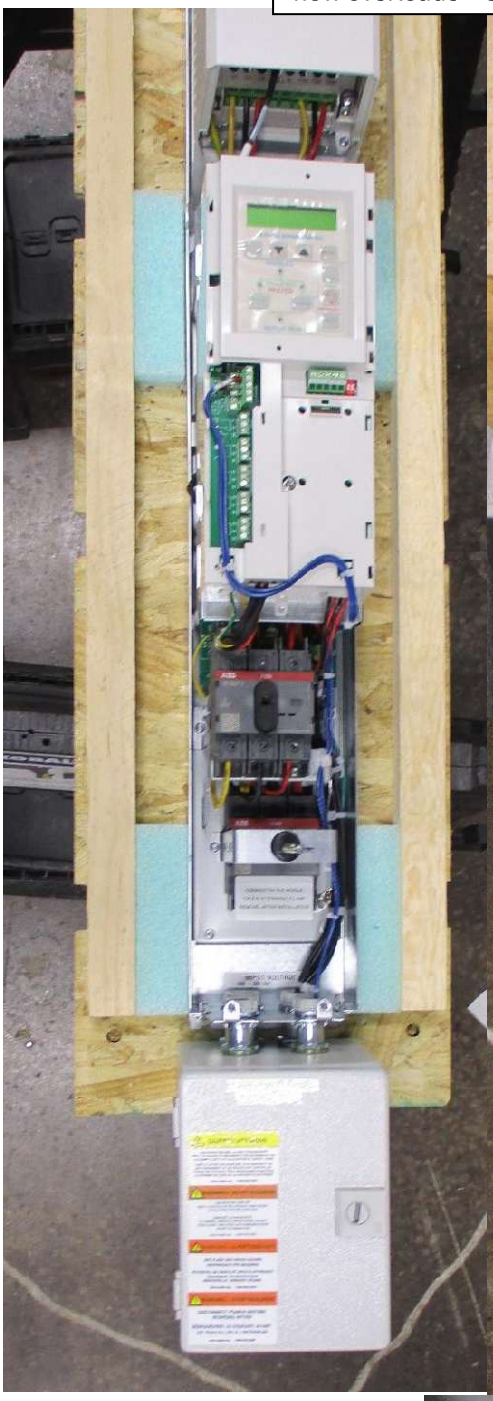
| Item | Part Number | Customer Designation |
|---|---|---|
| 1 | ACH580-PDR-017A-6 | |

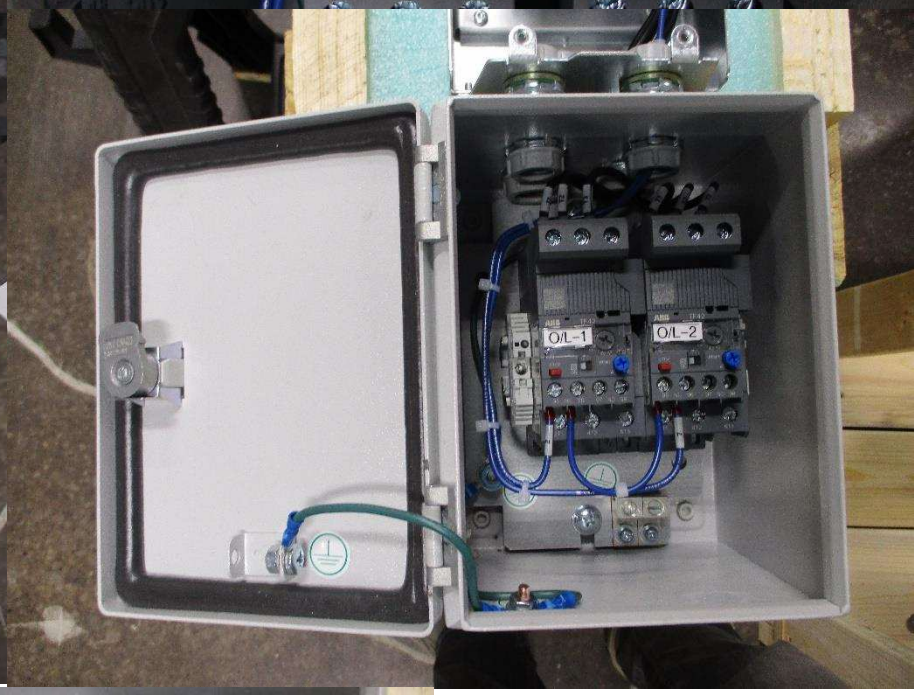



VFD
(NEMA 1)
NEMA 1 Enclosure housing dual overloads. Wiring/connection between VFD & overloads by ADM. Enclosure mounted to VFD by ADM.
Field wiring by contractor. Termination points in enclosure by contractor.
Field wiring by contractor. Termination points in enclosure by contractor.
Motor 1
Motor 2

OVERLOAD INSTALLATION EXAMPLE FROM A PREVIOUS JOB.

Note: this is a NEMA1 Bypass VFD package. This is to demonstrate how overloads + enclosure will be connected to VFD.




**HTS Oshawa**

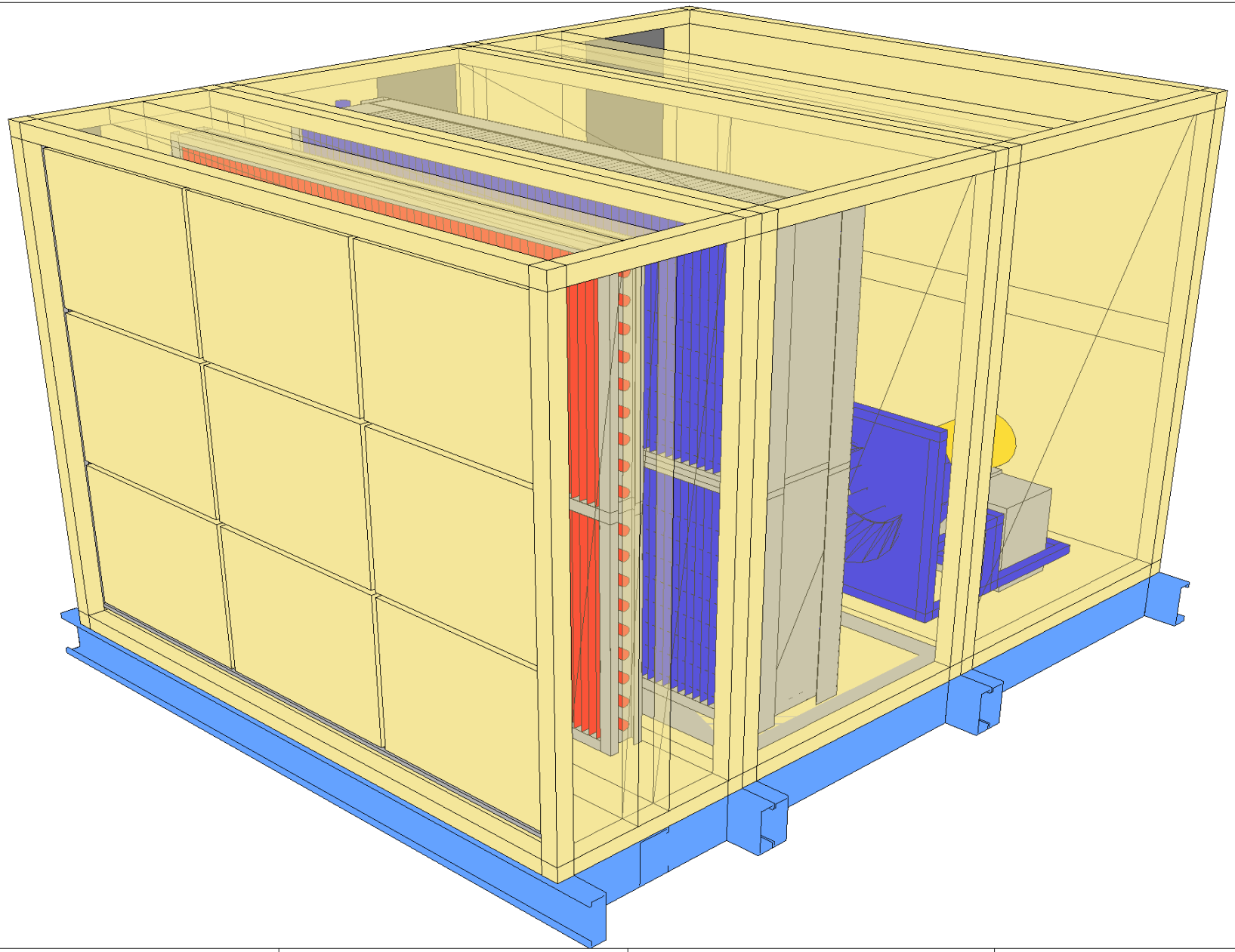
2001 Thickson Rd, South
Unit #11
Whitby, ON  L1N 6J3
T 905.579.6700
F 905.597.5290

ontario.htseng.com

SUBMITTAL DATA
APPROVAL REQUIRED

# IOM LINK

https://htseng-my.sharepoint.com/:f:/g/personal/curtis_metrow_hts_com/IgD_JwPmhDmwQZlNhdRqf-csAWEu08nbwsg2MnbpeWdmLds?e=AVpGVC



| | | | | | | |
|---|---|---|---|---|---|---|
| **Product Drawing** | Unit Tag: AHU-3 | | | Sales Office: HTS Engineering Ltd. | | |
| Product: Vision Air Handler | Project Name: 22600705 - DCDSB Archbishop DOC | | | Sales Engineer: | | |
| Model: CAH025GDGM | May 4, 2026 | Ver/Rev: | Sheet: 1 of 1 | Scale: NTS | Tolerance: +/-0.25" | Dwg Units: in |

DAIKIN
13600 Industrial Park Blvd, Minneapolis, MN 55441
www.DaikinApplied.com Software Version: 13.95

All opening dimensions have a 1" mounting flange along the inner edge. The actual airflow area of the opening is 2" smaller in each dimension.

## PART 1 - GENERAL

### 1.1 SUMMARY

.1 Section Includes:

- .1 Common work results and general provisions to establish a fully operational integrated automation system dedicated for the control, supervision, and management of building systems.
- .2 Common requirements to Division 25, including:
  - .1 Submittal procedures required to conduct a review of integrated automation as a whole.
  - .2 Coordination activities for systems and equipment that forms the integrated automation system.
  - .3 Common product requirements that apply to the entire integrated automation installation.
  - .4 Quality assurance requirements and procedures.
  - .5 Demonstration and training requirements for the integrated automation system as a whole.
  - .6 Requirements and procedures for closeout documents and operation and maintenance (O&M) manuals, related to integrated automation and other systems interfaced.

.2 This section specifies the overall architecture of the integrated automation system and defines the role of a Master Systems Integrator (MSI).

- .1 Designated MSI: The role of MSI will be performed by the supplier of the Centralized Building Management System (BMS) as described in QUALITY ASSURANCE in this section.

### 1.2 RELATED REQUIREMENTS

.1 Section 25 05 53 – Identification for Integrated Automation
.2 Section 25 24 00 – Integrated Automation System Architecture Requirements
.3 Section 25 30 00 – Integrated Automation Instrumentation and Terminal Devices
.4 Section 25 41 00 – Building Automation Controllers
.5 Section 25 45 00 – Centralized Building Management System
.6 Section 25 70 00 – Integrated Automation Building Systems Integration

### 1.3 DEFINITIONS

.1 Master Systems Integrator: Specialist responsible for coordinating and executing the integration work required for the integrated automation system. Responsibilities include coordinating interfaces between equipment, managing network and connection requirements, supervising devices/systems interconnections, and overseeing the overall integration process.

.2 Point: May be logical or physical.

- .1 Logical points: Values computed by the system such as setpoints, totals, counts, and derived corrections. Includes results of statements in control descriptive logic.
- .2 Physical points: Inputs or outputs connected to hardware wired to controllers. These inputs measure physical properties or provide status conditions of contacts or relays, facilitating interaction with related equipment, such as starting or stopping, and valve or damper actuators.

### 1.4 REFERENCE STANDARDS

.1 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):

.1 ANSI/ASHRAE 135-2020, BACnet – A Data Communication Protocol for Building Automation and Control Networks

.2 ULC Standards (ULC):

.1 CAN/ULC-S102.4:2017, Standard Method of Test for Fire and Smoke Characteristics of Electrical Wiring, Cables and Non-Metallic Raceways

## 1.5 ADMINISTRATIVE REQUIREMENTS

.1 Appoint an MSI to be responsible for administrative requirements specified in this section.

.2 Coordination:

.1 Coordinate with contract documents for removal and reinstallation of select controls and related items.

.2 Coordinate integration of components, equipment, software, applications, and third-party systems to meet the functionalities of the integrated automation system.

.3 Coordinate engagement of Subcontractors, manufacturers, and suppliers in:

.1 Verifying work conforms to the established integration standards.

.2 Reviewing submittals and installation requirements for system interfaces.

.3 Assisting testing and demonstration activities related to their work.

.4 Coordinate design and performance requirements of the overall integrated automation system to select the main components described in Section 25 24 00 – Integrated Automation System Architecture Requirements.

.5 Test, adjust, and balance reports: Readings and calibration completed in coordination with on air and water systems related to integrated automation.

.3 Integrated Automation Meetings: Arrange meetings to be attended by Consultant, Owner's Representative, and affected Subcontractors to:

.1 Coordination of integration:

.1 Review and coordinate equipment controls and interface requirements for integration with systems provided under Division 25.

.2 Before starting work:

.1 Review manufacturer literature and installation manuals related to systems, components, and equipment provided with built-in controls and interfaces.

.2 Coordinate and review network requirements, including network performance, data communication protocols used, location of connection points, and network security policies.

.3 During execution of work but before start of closeout activities:

.1 Debug issues related to systems integration.

.2 Review as-built records and final integration configuration/settings.

.4 Sequencing:

.1 Integrated systems: Test integrated systems only after testing for each individual system forming part of the integrated automation system has been completed.

## 1.6 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 – Submittal Procedures.

.2 Product Data: Product literature and data sheets, including product characteristics, performance criteria, and limitations for:

- .1 Submit product data for:
  - .1 Main system architecture components: Servers, workstations, operator interfaces, and related software.
  - .2 Instrumentation: Field instrumentation and control devices, actuators and operators, smart sensors, metering systems, and accessories.
  - .3 Networking equipment.
- .2 Submit with the related Shop Drawings for verification of compliance with the Specifications.

.3 Shop Drawings:

- .1 Preliminary Shop Drawings:
  - .1 Review critical products proposed for integrated automation and establish conformance with overall design philosophy, system performance, and capabilities.
  - .2 Submit preliminary Shop Drawings within 10 Working Days of award of Contract. Include:
    - .1 Product data and certificates of proposed building automation controllers, as specified in Section 25 41 00 – Building Automation Controllers.
    - .2 Product data and certificates of proposed software and applications for the centralized BMS, as specified in Section 25 41 00 – Building Automation Controllers.
    - .3 Sketch of site-specific system architecture.
    - .4 Description of software programs provided.

.2 Detailed Shop Drawings:

- .1 Submit Detailed Shop Drawings within 30 Working Days after award of Contract and before start of installation.
  - .1 Include corrected and updated versions of submissions made during preliminary review.
- .2 System architecture diagram: Submit detailed network architecture diagram showing all main components, control devices, and communication links of the integrated automation.
  - .1 Include:
    - .1 Components forming the centralized BMS, such as servers, operator workstation (OWS), operator interfaces, and data storage systems.
    - .2 Building automation controllers.
    - .3 Third-party control devices and interfaces.
    - .4 Network equipment.
    - .5 Communication links to show primary Ethernet transmission control protocol/internet protocol (TCP/IP) links and secondary buses. For each link, indicate data communication protocol used and cable type.
- .3 Floor plans: Indicate locations of controllers, auxiliary control cabinets, components of the centralized BMS, and network equipment.

.1 Show cable routings for power supply network and indicate locations of local distribution panels and transformers.

.4 Equipment Schedules:

.1 Control valves: Schedule listing with designation, service, manufacturer, model, point ID, design flow rate, design pressure drop, valve's flow coefficient (Cv) (required and actual), valve size, spring range, pilot range, torque (required and actual), close-off pressure (required and actual), and actuator details.

.2 Damper actuators: Schedule listing with designation, manufacturer, model, point ID, associated system ID, damper assembly dimensions, damper blade type, design airflow rate, normal position, spring requirements, torque (required and actual), power supply, and control signal type.

.3 Flow measuring stations: Schedule listing with designation, service, point ID, manufacturer, model, size, velocity at design flow rate, and operational range of transmitters.

.5 Building Controller Schedules: Points list indicating all points associated with each controller.

.1 Include:

.1 Point name, point ID, point description, sensor/transmitter type and range, signal type, and wiring termination details.

.2 Spare point capacity of each controller by number and type.

.6 Control schematics: For each building system or equipment under control of the integrated automation system.

.1 Include:

.1 System schematic (for example, ventilation/hydronic diagram) showing location of instrumentation, control devices, and system interface complete with point name and ID.

.2 Wiring diagrams.

.3 Interface wiring diagrams showing termination connections and signal levels for equipment supplied by other Divisions.

.7 Sequences of operation: For each control schematic in narrative format. Include description of automatic control required to achieve proper operation under normal conditions, on alarm detection, during a power failure, a fire alarm condition, and under complete failure of building automation controller.

.1 Include software and programming details such as time of day schedules, setpoints, and alarm limits (high and low, critical or non-critical).

.2 Cross-reference sequences of operation with control schematics, using the same point IDs and point names.

.8 Electrical system: Submit conduit layout for system wiring.

.4 Test and Evaluation Reports:

.1 Existing products intended for reuse: Test report within 40 Working Days of award of Contract listing each component to be reused and indicating whether it is in good conditions or requires repair.

.5 Manufacturer's Instructions:

.1 Special delivery, storage, and handling requirements.

.2 Installation instructions.

.3 Recommended sequencing.

.6 Material Delivery Schedule:

.1 Submit within 2 weeks of award of Contract.

.7 Training Program:

.1 Proposed training program and materials as specified in TRAINING in this section.

.2 Training agenda detailing hour-by-hour schedule and including brief content overview of each segment:

.1 List name of trainers and participants from project team, including the Consultant.

.1 The Owner's Representative will provide a list of participants that will attend training.

.2 Indicate type of visual and audio aids to be used during training.

.3 Indicate coordinated interface with other mechanical and electrical training programs.

.4 Submit minimum 30 days before beginning of training.

.3 Submit training completion report within [1] week after completion of training program stating satisfactorily training completion.

## 1.7 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 – Closeout Procedures.

.1 Submit minimum 2 weeks before beginning training.

.2 Operation and Maintenance Data:

.1 Include, in the operation and maintenance manual, manufacturer's maintenance and operating instructions.

.2 Use concise language and common terminology of functional and operational requirements of system, for clear understanding by operating personnel. Assume readers to have basic working knowledge of computers, electronics, or in-depth control theory.

.3 Include information related to systems forming the integrated automation system and subjects referred to in this section.

.1 Indicate name, address, and telephone number of each Subcontractor involved in the equipment installation and local representative for each item of equipment and system.

.4 Functional description to include:

.1 system operation;

.2 design philosophy and specific functions and systems;

.3 detailed data communication procedures, including data protocols used, data processing and data link components, interfaces, integration equipment, and procedures for checking data link integrity;

.4 detailed hardware and software functions, interfaces, and requirements for components in functions and operating modes; and

.5 detailed procedures for human-machine interactions (HMIs) required to supplement system description, known or established constraints on system operation, operation sequences,

and operating procedures currently implemented or planned for implementation in automatic mode.

.5 System operation description to include:

.1 detailed step-by-step procedures for system operation, including required actions at each interface (servers, OWS, HMIs);

.2 operation of computer peripherals, input and output formats;

.3 emergency, alarm, and failure recovery procedures and actions; and

.4 step-by-step instructions for start-up, back-up equipment operation, execution of systems functions, and operating modes. Include keystrokes for each command, allowing to easily reference the required keystrokes to call up display or to input command.

.6 Software description to include:

.1 software requirements and capabilities;

.2 data required for modification, relocation, reprogramming, and [new and existing] software modules to respond to changing system functional requirements without disrupting normal operation;

.3 comprehensive program cross-reference, including linking, data exchange, and data file requirements, necessary subroutine lists, and other essential information for loading, integrating, interfacing, and program execution;

.4 software for each controller, including a summary for controller common parameters and functions; and

.5 requirements for software updates, security patches and recommended update intervals, and software maintenance schedule.

.7 Maintenance procedures to include:

.1 document procedures for inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components;

.2 calibration, maintenance, and repair of sensors, transmitters, transducers, controllers, and interface firmware; and

.3 diagnostics and repair or replacement of system hardware.

.8 System configuration to include:

.1 provisions and procedures for planning, implementing, and recording hardware and software modifications required during operating lifetime of system; and

.2 information for coordination of hardware and software changes, data link or message format/content changes, and sensor or control changes in event that system modifications are required.

.3 Record Documentation:

.1 Submit updated version of documents generated during the detailed Shop Drawing review. Include:

.1 modifications made to installation, system configuration, control devices, and operation sequences through the course of the Project:

.1 change orders and other modifications to Contract;

.2 modifications to interface wiring;

.3 changes to cable routing and equipment location;

.4 changes made during commissioning process to meet the required performance;

.2 listing of alarm messages;

.3 Control Panel Schedule showing power source used. Indicate local distribution panel ID, circuit number, and source type (normal, emergency, or uninterruptible power supply (UPS));

.4 complete system control descriptive logics (CDLs) and include English explanations on same sheet, in different font and italics. Indicate specified energy optimization programs.

.5 Record important settings and parameters configured during construction progress such as minimum damper positions and supply air static pressure setpoints.

.2 Submit soft copy incorporating changes made during final review.

.4 Certificates and Test Reports:

.1 Test procedures and reports: Provide records of start-up procedures, test procedures, checkout tests, and final commissioning reports

.2 Calibration certificates for metering systems and equipment.

.5 Building Systems Integration Manual:

.1 Log book documenting building systems integration data, testing results, and final configuration settings.

## 1.8 QUALITY ASSURANCE

.1 Qualifications:

.1 MSI:

.1 Perform systems integration at the automation level using the building's centralized BMS. MSI services to be provided by the centralized BMS Supplier as described in Section 25 45 00 – Centralized Building Management System.

.2 Trainers:

.1 Instructors with expertise in all aspects of the integrated automation system installed in the facility.

.2 Head instructor appointed from contractors, equipment Suppliers, or manufactures with extensive knowledge of system functionalities, operations, and safety protocols.

.3 The Consultant reserves the right to approve instructors.

## 1.9 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store, and handle materials in accordance with Section 01 61 00 - Common Product Requirements,

## 1.10 WARRANTY

.1 Provide a warranty on all work provided under Division 25, including equipment, materials, software, hardware, wiring, and programming.

.2 Provide services, materials, and equipment to maintain the integrated automation system for specified warranty period.

.1 Provide detailed preventative maintenance schedule for system components.

.3 Software Maintenance During Warranty Period:

.1 Upgrade software and applications to their latest revision at the start of the warranty.

.2 Provide software updates during the warranty period including updates to software, applications, and security patches.

.3 Submit manufacturer's recommendations or technical bulletins before updating or upgrading software and security patches.

.4 Emergency Service Calls During Warranty Period:

.1 Provide qualified personnel during warranty period to perform service to critical components whenever required or when integrated automation system is not functioning satisfactorily.

.2 Service personnel to be on site, ready to service systems, within [4] hours after receiving request for service.

.3 Work continuously at no extra costs until systems are restored to reliable operating condition.

.4 System Modifications:

.1 Indicate system modifications in writing.

.2 Obtain written approval Consultant for system modifications, including operating parameters and control settings.

.3 Revise and re-submit CLOSEOUT SUBMITTALS to reflect changes, adjustments, and modifications made during warranty period.

.4 Extended Warranty:

.1 For the work of this section, the 12-month warranty period is extended to 24 months.

## Part 2 Products

### 2.1 DESCRIPTION

.1 Work covered in Division 25 provides a fully operational integrated automation system and a unified automation environment designed to consolidate various automation systems, control devices, software, and applications to promote data exchange, data collection, and optimization of building operations.

.2 The integrated automation system, as a whole, consists of components that control and manage building systems. This system includes products specified in Division 25 and third-party components described in other Divisions, consisting of:

.1 Building controllers: Network of building automation controllers as specified in Section 25 41 00 – Building Automation Controllers.

.2 Field instrumentation and control devices as specified in Section 25 30 00 – Integrated Automation Instrumentation and Terminal Devices.

.3 Centralized BMS: Software-based platform to provide a user interface for integrated automation as specified in Section 25 45 00 – Centralized Building Management System.

.4 Servers, operator workstations, operator interfaces, and database storage to support the centralized BMS as specified in Section 25 24 00 – Integrated Automation System Architecture Requirements.

.5 Interface of third-party systems and components as described in Section 25 70 00 – Integrated Automation Building Systems Integration.

.6 Network infrastructure to support integrated automation as specified in Section 25 17 00 – Operational Technology Networks for Integrated Automation.

.7 Data analytics software.

## 2.3 PERFORMANCE/DESIGN CRITERIA

.1 Design Criteria:

.1 Equip each system or component interfaced to the integrated automation system with the necessary hardware and software to operate independently and perform their basic control functions.

.1 Building automation controllers perform direct control and supervision of selected systems and equipment.

.2 Supply third-party systems and components with built-in controls and interface to allow the integrated automation system to poll data and modify control functions and settings.

.3 Use data exchange for data collection, to perform optimization control and display system data at user interfaces.

.2 The integrated automation environment prioritizes the use of internet protocol (IP) communications to enable data exchange between system components (communications at system level) and data exchange between systems (cross-system communications).

.1 Perform communication at other levels (secondary buses) through integration panels, building automation controllers equipped with router or gateway functions.

.2 Perform exchange between software through the centralized BMS by using a database interface such as an application programming interface (API).

.3 Provide equipment, components, and software specifically developed to operate in accordance with ANSI/ASHRAE 135. Prioritize products that use communication interfaces that conform with the Ethernet standard, the IP protocol suite, and BACnet/IP in accordance with ANSI/ASHRAE 135, Annex J.

.4 Use one of the following standard open protocols, in order of preference, when a product requiring a communication interface does not support BACnet/IP:

.1 BACnet MS/TP;

.2 System Database:

.1 Integrated automation relies on the centralized BMS to host the system database. System data (for example, control points, historical data, parameters) must reside in a SQL based database as specified in Section 25 45 00 – Centralized Building Management System.

.2 Data exchange with other software applications, at an enterprise-level, is possible through the system database using a connector tool such as the following APIs:

.1 Microsoft Open Database Connectivity (ODBC); or

.2 Java Database Connectivity (JDBC).

.3 Language Operating Requirements: Provide text in English.

.1 Graphic terminal displays: Use non-linguistic symbols for displays on graphic terminals whenever possible.

.2 Operating system executive: Provide primary hardware-to-software interface as part of hardware purchase, with associated documentation in English.

.3 System manager software: Include system definition point database, additions, deletions or modifications, control loop statements, use of high-level programming languages, report generator utility, and other operating system utilities necessary for maintaining optimal operating efficiency.

.1 Input and output commands: Input and output commands and messages from operator-initiated functions, Alarms as defined in CDL's or assigned limits (such as commands relating to day-to-day operating functions and not to system modifications, additions, or logic redefinitions).

.2 Graphic "display" functions, point commands to turn systems on/off, and manual overrides of automatic control for specified hardware points to be available in English at specified OWS.

.1 System to be able to operate one terminal in English.

.2 Provide point name expansions in both languages.

.3 Reporting function such as trend log, trend graphics, alarm report logs, energy report logs, and maintenance generated logs.

.4 Electrical:

.1 Provide complete conduit system for system wiring.

.1 Provide separate conduit systems for line-voltage power wiring and for instrumentation and communication wiring.

.2 Conduit sizes to suit wiring requirements and to allow for future expansion capabilities specified for systems.

.3 Conduit fill: Maximum of 40%.

.2 Provide utility power to components of the integrated automation system from dedicated circuits in local distribution panels as indicated on Drawings.

.3 Power supply and conditioning equipment: Provide all transformers, DC power supplies, and low voltage power networks required to power local controllers, field instrumentation, and control devices.

.1 Power supplies complete with over-voltage protection module and sized for two times the connected load.

## 2.4 WIRING

.1 70 V and Above: Copper conductors in accordance with Division 26.

.2 Under 70V: Use FT6-rated wiring where wiring is not run in conduit, and FT4-wiring in other cases, in accordance with CAN/ULC-S102.4.

.3 Sizes:

.1 120 V power supply: Match or exceed the current rating of the breaker.

.1 Minimum wire size: #12 AWG.

.2 Wiring for safeties and interlocks: For starters and motor control centres.

.1 Minimum wire size: #12 AWG.

.3 Field wiring: Shielded wire.

.1 Minimum wire size: #18 AWG solid copper.

.4 Power loss through conductor not to exceed 5%.

.5 Colour coding and cable jacket colours: In accordance with Section 25 05 53 – Identification for Integrated Automation.

### 2.5 SOURCE QUALITY CONTROL

.1 Provide equipment and material from manufacturer's regular production, CSA certified, and manufactured to specified standards and requirements.

.2 Where CSA certified equipment is not available, submit equipment to AHJ for special inspection and approval before delivery to site.

.3 Submit proof of compliance to specified standards with Shop Drawings and product data. Label or listing of specified organization is acceptable evidence.

.4 Provide calibration certificates for products that require certificates after production or when installed and started-up at the site.

.5 If the original documentation cannot be provided, submit certificate from testing organization, acceptable to the Consultant, certifying that item was tested in accordance with their test methods and conforms to their standards and codes.

.6 For material not regulated by the organization's own listing or labeling, provide a certificate stating that the material complies with the applicable reference standards, specifications, and codes specified in Section 01 41 00 – Regulatory Requirements.

## Part 3 Execution

### 3.1 INSTALLATION

.1 Install and configure components in accordance with manufacturer's recommendations.

.2 Install equipment and components so that manufacturers and CSA labels are visible and legible after commissioning is complete.

.3 Electrical:

- .1 Install electrical components in accordance with requirements in Division 26.
- .2 Modify existing starters to provide integrated automation control
- .3 Terminate wires with screw terminal type connectors suitable for wire size and number of terminations.
- .4 Provide grounding for the integrated automation installation and components in accordance with Division 26 requirements.
- .5 Wiring in conduits:
  - .1 Install all wiring in electrical metallic tubing (EMT) conduit.
  - .2 To be continuous without joints.
  - .3 Install conduits parallel or perpendicular to building lines to conserve headroom and minimize interference.
  - .4 Avoid running exposed conduits in normally occupied spaces unless impossible to do otherwise.
    - .1 When impossible to do otherwise, obtain written authorization the from Consultant before starting work.
    - .2 Enclose wiring in conduit in mechanical and service rooms, as well as any exposed wiring.
- .6 Wiring outside conduits:
  - .1 FT6 plenum-rated wiring may run without conduits in accessible ceiling space to connect building controllers and their components. This includes wiring for:
    - .1 low-voltage power supply and communication links; or

.2 field instrumentation, operators, and actuators.

.2 Run wiring parallel or perpendicular to building lines. Secure wiring with cable supports every 2 m.

.1 Cable supports: Reconfigurable system such as hook-and-loop fastener straps. Avoid using tape or tie-wraps.

.3 Wiring to be continuous without joints.

.4 Fix cable supports to building structure. Avoid attaching wiring to building systems, such as electrical conduits, ductwork, piping, or their associated hangers.

.5 For wall-mounted components, run wiring in conduit inside the wall and up to the ceiling space. At the end of the conduit, install a plastic ring to protect wiring against abrasion.

.7 Identify conduits and wiring in accordance with Section 25 05 53 – Identification for Integrated Automation.

## 3.2 PROGRAMMING AND CONFIGURATION

.1 All programming performed in Division 25 to be self-documenting.
.2 Programs of similar systems to be standardized and follow a common structure.
.3 The Consultant has the right to revise the sequence or subsequent CDL before software finalization without incurring additional costs.
.4 Record Documentation: Enter soft copy submission of O&M manuals and record documentation at each server and OWS.

## 3.3 PAINTING

.1 Paint, and:

.1 Clean and touch up damaged or scratched surfaces of factory-finished equipment to match original finish.

.2 Restore extensively damaged finished surfaces to be primed and touched up.

.3 Clean and prime exposed hangers, racks, fastenings, and other support components.

## 3.4 ADJUSTING

.1 Corrections: Provide equipment, materials, and labour as required to correct installation or equipment deficiencies identified through the construction process.

## 3.5 CLOSEOUT ACTIVITIES

.1 Training: Provide system and project-specific training to designated personnel for adjustment, operation, maintenance, and pertinent safety requirements of installed systems in accordance with Section 01 79 00 – Demonstration and Training

.1 Delivery method: 4-hour site walk-through followed by 4-day Classroom training for 1 staff.

.2 Training schedule: Perform training after project completion.

.3 1 day is equivalent to 8 hours, including two 15-minute breaks and excluding lunch time.

.4 Train O&M personnel in functional operations and procedures for system operation. Content to cover maintenance of equipment, including general equipment layout, troubleshooting and preventive maintenance of integrated automation components, maintenance, and calibration of sensors and controls.

.1 Perform on-the-job training during 30-day test period.

.2 Include overview of system architecture, communications, interconnection, operation of integrated automation system and peripherals, report generation, archive, and trend logs.

.3 Include detailed training on operator interface functions for managing building systems under control of integrated automation, CDL's for each system, and preventive maintenance.

.1 Software architecture and application programs.

.2 Controller programming and configuration

.3 Troubleshooting and debugging

.4 Alarm, scheduling, and event management

.5 Generation of graphics, trend logs and reports

.6 Energy optimization features, such as energy management applications, energy reporting tools, fault detection, diagnosis rules and parameters, and building analytics software.

.5 Monitoring of training:

.1 The Consultant to monitor training program and modify schedule and content, if necessary.

**END OF SECTION**

## PART 1- GENERAL

### 1.1 SUMMARY

.1 Section includes:

.1 Requirements and procedures for identification of devices, sensors, wiring, tubing, conduits, and equipment related to integrated automation.

.2 Nameplate materials, colours, and lettering sizes to use for identification.

.3 Identification of other building systems and components interfacing with or under control of integrated automation systems.

### 1.2 RELATED REQUIREMENTS

.1 Section 23 05 00 – Common Work Results for Mechanical

.2 Section 26 05 00 - Common Work Results for Electrical

### 1.3 REFERENCE STANDARDS

.1 CSA Group (CSA):

.1 CSA C22.1-18, Canadian Electrical Code, Part I (24th Edition), Safety Standard for Electrical Installations

### 1.4 ADMINISTRATIVE REQUIREMENTS

.1 Coordination:

.1 Coordinate with Section 26 05 00 - Common Work Results for Electrical for equipment identification, nameplates and labels, wiring identification, conduit and cable identification, and finishes.

### 1.5 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 - Submittal Requirements and Section 25 05 00 - Common Work Results for Integrated Automation.

.2 Samples:

.1 Samples for verification: Manufacturer's standard samples to verify selected colours, patterns, textures, and finishes.

.1 Submit samples for:

.1 Nameplates.

.2 Identification tags.

.3 Wording List: Proposed wording for nameplates and identification tags.

.4 Colour-Coding: Proposed scheme for colour-coding conduits and wiring.

## PART 2- PRODUCTS

### 2.1 DESCRIPTION

.1 Provide identification for items related to integrated automation in English.

## 2.2 NAMEPLATES FOR PANELS

.1 Identify by plastic laminate, 3 mm thick melamine, matte white finish, black core, square corners, lettering accurately aligned and engraved into core.

.2 Sizes: Minimum 25 mm x 67 mm.

.3 Lettering: Minimum 7 mm high.

.4 Inscriptions: Machine engraved to identify function.

## 2.3 INPUT/OUTPUT (I/O) SCHEDULES FOR PANELS

.1 Provide a printed I/O Schedule for each panel containing automation controllers and system I/O. Enclose in a clear plastic envelope hung inside the panel door.

.1 I/O Schedule: Include panel name, controller name, legend, I/O point name, I/O point description, I/O point address on controller, description of field device connected to I/O point, and the Schedule's revision date.

## 2.4 NAMEPLATES FOR FIELD DEVICES

.1 Identify by plastic-encased cards attached by plastic tie.

.2 Sizes: Minimum 50 mm x 100 mm.

.3 Lettering: Minimum 5 mm high, produced from laser printer in black.

.4 Data: Include point name and point address.

.5 Field devices inside panels: Identify by pre-printed self-adhesive vinyl labels using point name.

## 2.5 NAMEPLATES FOR ROOM SENSORS

.1 Identify by pre-printed self-adhesive vinyl labels using point name.

.2 Neatly cut and affix labels on room sensor.

.3 Location: As directed by the Consultant.

.4 Adjust letter size for legibility.

## 2.6 LOCATION INDICATORS FOR FIELD PANELS

.1 Identify locations of field panels installed in concealed spaces (for example, in ceiling spaces, behind access panels, etc.) with orange coloured self-adhesive labels, 25 mm x 25 mm size. Include panel name in legible lettering.

## 2.7 WARNING SIGNS

.1 Equipment including motors, starters under automatic remote control: Supply and install orange coloured signs warning of automatic starting under control of the building automation system (BAS).

.2 Sign to read, "Caution: This equipment is under automatic remote control of BAS", as reviewed by the Consultant.

## 2.8 WIRING

.1 Supply and install numbered tape markings on wiring at panels, junction boxes, splitters, cabinets, and outlet boxes.

.2 Colour-coding: In accordance with Section 26 05 00 - Common Work Results for Electrical.

.3 Power Wiring: Identify circuit breaker panel/circuit breaker number inside each panel.

.4 Wiring for controls and automation systems:

.1 Identify wiring end to end with indelible numbered markings or pre-printed labels.

.2 Use distinctive colour-coded cable jackets to identify different types of cabling used throughout system.

.1 Wiring for field devices (I/O wiring): Grey cable jacket.

.2 Wiring for automation networks: Orange cable jacket.

.5 Label all manual switches, unless they come with standard nameplates, with engraved plastic laminate nameplates to clearly indicate the service. Wording on nameplates to be subject to acceptance of the Consultant.

### 2.9 CONDUIT

.1 Colour-code conduits related to integrated automation.

.2 Pre-paint box covers and conduit fittings.

.3 Coding: Use fluorescent orange paint and confirm colour with the Consultant during submittal review.

## PART 3- EXECUTION

### 3.1 INSTALLATION OF NAMEPLATES AND LABELS

.1 Install nameplates parallel to equipment lines, on the outside of the enclosure or on the device immediately adjacent to it.

.2 Avoid interference of nameplates with equipment operation and maintenance.

.3 Secure nameplates with a minimum of two sheet-metal screws, two rivets, adhesive, or cable ties.

.1 Adhesive installation:

.1 Clean the surface using a manufacturer-approved solvent or cleaning agent and verify that surface is dry and free from dust, oil, and debris.

.2 Apply adhesive according to manufacturer's instructions.

.4 Verify manufacturer's nameplates, CSA labels, and identification nameplates are visible and legible at all times.

### 3.2 EXISTING PANELS

.1 Correct existing nameplates and I/O Schedule to reflect changes made during Work.

**END OF SECTION**

## PART 1- GENERAL

### 1.1 SUMMARY

.1 Section Includes:

.1 System requirements for Local Area Network (LAN) for Building Energy Monitoring and Control System (EMCS).

### 1.2 REFERENCE STANDARDS

.1 CSA Group (CSA):

.1 CSA T529-[95], Telecommunications Cabling Systems in Commercial Buildings (Adopted ANSI/TIA/EIA-568-A with modifications)

.2 CSA T530-[99], Commercial Building Standard for Telecommunications Pathways and Spaces (Adopted ANSI/TIA/EIA-569-A with modifications)

.3 Institute of Electrical and Electronics Engineers (IEEE)/Standard for Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements:

.1 IEEE Std 802.3TM-[2002], Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications

.2 Telecommunications Industries Association (TIA)/Electronic Industries Alliance (EIA):

.1 TIA/EIA-568-[March 2004], Commercial Building Telecommunications Cabling Standards Set, Part 1 General Requirements Part 2 Balanced Twisted-Pair Cabling Components Part 3 Optical Fiber Cabling Components Standard

.2 TIA/EIA-569-A-[December 2001], Commercial Building Standard for Telecommunications Pathways and Spaces

### 1.3 SYSTEM DESCRIPTION

.1 Data communication network to link Operator Workstations and Master Control Units (MCU) in accordance with CSA T529,TIA/EIA-568 and CSA T530, TIA/EIA-569-A

.1 Provide reliable and secure connectivity of adequate performance between different sections (segments) of network.

.2 Allow for future expansion of network, with selection of networking technology and communication protocols.

.3 Data communication network to include, but not limited to:

.1 EMCS-LAN.

.2 Modems.

.3 Network interface cards.

.4 Network management hardware and software.

.5 Network components necessary for complete network.

### 1.4 DESIGN REQUIREMENTS

.1 EMCS Local Area Network (EMCS-LAN).

.1 High speed, high performance, local area network over which MCUs and OWSs communicate with each other directly on peer to peer basis in accordance with IEEE 802.3/Ethernet Standard.

.2 EMCS-LAN to: BACnet

.3 Each EMCS-LAN to be capable of supporting at least 50 devices.

.4 Support of combination of MCUs and OWSs directly connected to EMCS-LAN.

.5 High speed data transfer rates for alarm reporting, quick report generation from multiple controllers, upload/download information between network devices. Bit rate to be 10 Megabits per second minimum.

.6 Detection and accommodation of single or multiple failures of either OWSs, MCUs or network media. Operational equipment to continue to perform designated functions effectively in event of single or multiple failures.

.7 Commonly available, multiple sourced, networking components and protocols to allow system to co-exist with other networking applications including office automation.

.2 Dynamic Data Access.

.1 LAN to provide capabilities for OWSs, either network resident or connected remotely, to access point status and application report data or execute control functions for other devices via LAN.

.2 Access to data to be based upon logical identification of building equipment.

.3 Network Medium.

.1 Network medium: fibre optic cable compatible with network protocol to be used within buildings. Fibre optic cable to be used between buildings.

## PART 2- PRODUCTS

### 2.1 NOT USED

.1 Not Used.

## PART 3 - EXECUTION

### 3.1 NOT USED

.1 Not Used.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 SUMMARY

.1 Section Includes:

- .1 Main system architecture required to support integrated automation systems and host software and integrated functionalities, such as the centralized building management system, system databases, and historical data archival and back-up/recovery systems.
- .2 Main architecture components, including:
  - .1 system servers: server type, performance, and configuration;
  - .2 operating systems;
  - .3 database software;
  - .4 operator workstations and other human-machine interfaces (HMIs); and
  - .5 connection to external cloud services.

.2 System architecture is not solely dedicated to support building automation controllers and the centralized building management system (BMS). The system is used to host additional software and third-party applications related to integrated automation, as indicated in this Section.

.3 Coordination activities to verify equipment and software selected meet overall project performance and design criteria.

### 1.2 RELATED REQUIREMENTS

.1 Section 25 05 00 – Common Work Results for Integrated Automation
.2 Section 25 45 00 – Centralized Building Management System

### 1.3 ADMINISTRATIVE REQUIREMENTS

.1 Coordination:

- .1 Coordinate and supervise work related to the products specified in this section to provide a main system architecture that complies with PERFORMANCE/DESIGN CRITERIA in this section.
  - .1 Install and configure all software, applications, and databases hosted on the main system architecture.
- .2 Coordinate with Suppliers to obtain and review specific hardware/software requirements for each software application to be installed on the main system architecture.
  - .1 Collect and coordinate all requirements to compile overall performance requirements for servers, operator workstations, and data storage systems.
- .3 Review the Owner's security policies for installing components on their network.
- .4 Coordinate server and workstation performance requirements with Owner.

.2 Integrated Automation Meetings: Conduct a meeting, before submitting Product Data, in accordance with Section 25 05 00 – Common Work Results for Integrated Automation and attended by the Consultant, Suppliers, and appropriate Subcontractors to:

- .1 Discuss deployment of main system architecture.
- .2 Provide an overview of the proposed main system architecture and coordinate installation and configuration requirements.

.3 Review the Owner's security policies.

.4 Coordinate performing system backups and software updates.

### 1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 25 05 00 – Common Work Results for Integrated Automation.

.2 Product Data: Product literature and data sheets for each product item proposed for this Project, including product characteristics, performance criteria, manufacturer names, product numbers, and limitations.

.1 Submit list of software and applications to be installed on servers and workstations. For each software, include manufacturer's recommended hardware/software performance.

.3 Server Requirements:

.1 Submit at the beginning of the Project:

.1 required version of Windows server;

.2 processor requirements;

.3 dynamic memory (RAM) requirements;

.4 hard disk and partition requirements;

.5 access permissions; and

.6 other services required to allow the necessary software and applications to be installed and to run adequately.

## PART 2 - PRODUCTS

### 2.1 SYSTEMS DESCRIPTION

.1 The integrated automation main system architecture includes a number of servers and computers primarily used to support the centralized-BMS, the main software platform used to interface with building systems and provide a user interface for building control and management.

.2 The main system architecture is used to support other software and applications for building control and management or integrated automation, including:

.1 software for programming building automation controllers;

.2 energy analytics;

.3 lighting controls;

.4 energy metering software;

.5 room scheduling software;

.6 fault detection and diagnostics software; and

.3 System Architecture:

.1 Include the following components:

.1 Server: Used to host the main operating software and software applications.

.1 Physical server is located at Durham Catholic District School Board Headquarters.

.2 Data storage system: Used for long-term storage of historical data.

.1 Configure data storage on server's hard disks.

.3 Software and licenses: Systems to include the necessary software and licenses for the server operation and running applications, including the required Windows platform, database software, and virtual server license.

### 2.3 PERFORMANCE/DESIGN CRITERIA

.1 Select systems specified in this Section to host software and applications described in SYSTEM DESCRIPTION in this section. When selecting products, verify performance meets manufacturer's recommendations.

.1 Review performance requirements to host the centralized-BMS as specified in Section 25 45 00 – Centralized Building Management System. Obtain manufacturer literature detailing server and OWS requirements and verify with owner that the existing server will meet manufacturer's recommendations.

.2 Review manufacturer literature and recommendations with other software/applications Suppliers for which the main system architecture will be used as the hosting environment.

.2 System components communicate with other devices residing on the primary Ethernet TCP/IP network.

.1 All systems communicate in accordance with the Ethernet standard and the IP protocol suite and operate under Windows' latest platform.

.2 The main system architecture supports a multi-user and multi-task operation for the centralized-BMS.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

.1 Coordinate location of equipment provided under this Section with the Consultant.

.2 Server and Workstations:

.1 Install and configure operating systems and licenses required for the overall system operation under the supervision of the Owner's IT department and in accordance with their policies and security requirements.

.2 Update software and applications to their latest revisions at time of project completion.

.1 Review updates and patches with other software Suppliers to ensure compliance of their products with the proposed update.

.3 Software Installation and Configuration:

.1 Supervise and maintain responsibility for all software installed on servers and workstations, including applications provided by others.

.2 Configure access permissions and disk partitions to host the bundle of software and applications within the server environment.

### 3.2 AS-BUILT RECORDS

.1 Enter soft copy submission of as-built record documents in accordance with Section 25 05 00 – Common Work Results for Integrated Automation in server.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 SUMMARY

.1 Section Includes:

.1 Field instrumentation and control devices for integrated automation systems, including sensors, transmitters, switches, transducers, low voltage current transformers, and controls.

### 1.2 RELATED REQUIREMENTS

.1 Section 25 90 00 – Integrated Automation Control Sequences
.2 Section 07 84 00 – Firestopping
.3 Section 25 05 00 – Common Work Results for Integrated Automation
.4 Section 25 05 53 – Identification for Integrated Automation
.5 Section 26 05 00 – Common Work Results for Electrical
.6 Section 26 05 32 – Outlet Boxes, Conduit Boxes and Fittings

### 1.3 REFERENCE STANDARDS

.1 Air Movement and Control Association International (AMCA):

.1 ANSI/AMCA Standard 610-19, Laboratory Methods of Testing Airflow Measurement Stations for Performance Rating

.2 CSA Group (CSA):

.1 CSA C22.1-18, Canadian Electrical Code, Part I (24th Edition), Safety Standard for Electrical Installations

.3 IEEE Standards Association (IEEE):

.1 IEEE C57.13-2016, Standard Requirements for Instrument Transformers

.4 International Organization for Standardization (ISO):

.1 ISO 9060:2018, Solar energy – Specifications and classification of instruments for measuring hemispherical solar and direct solar radiation

.5 National Electrical Manufacturers Association (NEMA):

.1 ANSI/NEMA 250-2020, Enclosures for Electrical Equipment (1000 Volts Maximum)

### 1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 - Submittal Procedures and Section 25 05 00 – Common Work Results for Integrated Automation.
.2 Product Data: Product literature and data sheets for field instrumentation and control devices, including product characteristics, performance criteria, and limitations.
.3 Shop Drawings:

.1 Show location of each component, dimensioned plans, large scale details, and attachment details.

.4 Samples:

.1 Samples will be returned for use in the Work.

.5 Manufacturer's Instructions:

.1 Special delivery, storage, and handling requirements.

.2 Installation instructions.

.3 Recommended sequencing.

### 1.5 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store, and handle materials in accordance with Section 01 61 00 - Common Product Requirements

## PART 2 - PRODUCTS

### 2.1 GENERAL

.1 Control devices of each category to be of same type and manufacturer.

.2 Terminations: Standard conduit box with slot screwdriver compression connector block in accordance with Section 26 05 32 – Outlet Boxes, Conduit Boxes and Fittings.

.3 Performance/Design Criteria:

.1 Operating conditions:

.1 Temperature: 0 to 32 °C.

.2 Relative humidity (RH): 10 to 90%, non-condensing.

.2 Provide transmitters and sensors unaffected by external transmitters such as walkie-talkies.

.3 Account for hysteresis, relaxation time, and maximum and minimum limits in applications of sensors and controls.

.4 Outdoor installations: Use weatherproof construction Type 4 enclosures in accordance with CSA C22.1.

.5 Devices installed in user-occupied space not to exceed noise criteria (NC) of 35.

.1 Prevent noise generated by devices from being detectable above space ambient conditions.

.6 Ranges: Including temperature, humidity, and pressure, as indicated in Section 25 90 00 – Integrated Automation Control Sequences.

### 2.2 TEMPERATURE SENSORS

.1 Resistance-Type Except for Room Sensors:

.1 Resistance temperature detectors (RTDs): 10k ohm platinum element with strain minimizing construction, and three integral anchored lead wires.

.1 Coefficient of resistivity: 0.00385 ohm/ohm/°C.

.2 Accuracy: ± 0.2 °C.

.3 Sensing element: Hermetically sealed.

.4 Stem and tip construction: Copper or Type 304 stainless steel.

.5 Time constant response: Maximum 3 seconds to temperature change of 10 °C.

.2 Duct Temperature Sensors:

.1 General purpose duct type: Suitable for insertion into ducts at various orientations, probe length 460 mm or half of duct size at insertion point.

.2 Averaging duct type: Incorporates various sensors inside assembly which are averaged to provide one reading.

.1 Insertion length: Minimum 6000 mm.

.2 Bend probe at field installation time to 100 mm radius at any point along probe without decline in performance.

.3 Immersion Sensors:

.1 Immersion-type sensor for measurement of fluids in process piping, minimum insertion length of 25 mm spring-loaded construction for thermowell installation.

.2 Thermowells: NPS 3/4, and stainless steel construction with heat transfer compound compatible with sensor.

.4 Room Temperature Sensors:

.1 General:

.1 Element: 1k ohm platinum RTD or negative temperature coefficient (NTC) thermistor type.

.2 Accuracy: ± 0.3 °C.

.3 Sensing element: Hermetically sealed.

.4 Designed for wall mounting applications.

.2 For room sensing only:

.1 Wall-mounted enclosure with slotted type cover having brushed stainless steel finish.

.3 Room sensing with display:

.1 LCD display for space temperature and setpoint value.

.2 Local buttons for temperature setpoint adjustment and occupied/unoccupied mode.

.3 Separate mounting base for easy installation.

## 2.3 TEMPERATURE SWITCHES

.1 Requirements:

.1 Operates and resets automatically, except as follows:

.1 Low temperature protection: Manual reset.

.2 High temperature protection: Manual reset.

.2 Adjustable setpoint and differential.

.3 Snap action rating: 24 V dc.

.1 Switch: Double pole, single throw (DPST) for hardwire connections.

.2 Type:

.1 Room thermostat: For wall mounting on standard electrical box with protective guard.

.2 Duct-mounted thermostat: General purpose thermostat for duct insertion, probe length of 460 mm.

.3 Freezestat: Thermostat for low temperature detection, continuous element with 6000 mm insertion length, duct mounting, to detect coldest temperature in any 30 mm length.

.4 Immersion thermostat: Complete with stainless steel thermowell, compression fitting for NPS 3/4 thermowell.

.1 Immersion length: 100 mm.

## 2.4 HUMIDITY TRANSMITTERS

.1 Sensing Element: Polymer-based capacitance.
.2 Output Signal: 4 to 20 mA onto 500 ohm maximum load.
.3 Input and output short circuit and open circuit protection.
.4 Operating Temperature Range: -40 to 50 °C.
.5 Temperature Effect: Temperature compensated humidity sensor.
.6 Operating Humidity Range: Minimum 0 to 99% RH.
.7 Accuracy: ± 2% RH.
.8 Long Term Output Drift: Maximum 0.5% of full-scale output over 6 months.
.9 Transmitters and Sensors: National Institute of Standards and Technology (NIST) traceable and certified.
.10 For Room Sensing: Wall mounted and locate near return air (RA) grille.
.11 Duct-Mounted Sensors: Type 4 enclosure in accordance with CSA C22.1

## 2.5 CARBON DIOXIDE TRANSMITTERS

.1 General:

.1 Microprocessor-based with non-dispersive infrared (NDIR) optical sensor and integrated self-calibration algorithm.

.2 Detection range: 0 to 2000 ppm.

.3 Minimum accuracy: ± 3% over detection range.

.4 Output signal: 4 to 20 mA or 0 to 10 V dc.

.5 Response time: Maximum 60 seconds.

.2 Room Sensing Applications:

.1 For wall mounting, complete with ventilated acrylonitrile butadiene styrene (ABS) plastic enclosure, blank cover and mounting base.

.2 Operating conditions:

.1 Temperature: 0 to 40 °C.

.2 Relative humidity: 0 to 95%, non-condensing.

.3 Duct-Mounting Applications:

.1 Integrated transducer and probe for insertion into ventilation ducts.

.2 Enclosure: Plastic housing with blank cover mounting plate, and national pipe thread (NPT) conduit adapter.

.3 Operating conditions:

.1 Temperature: 0 to 50 °C.

.2 Relative humidity: 0 to 95%, non-condensing.

## 2.6 OCCUPANCY SENSORS

.1 General:

- .1 Sensor type: Passive infrared (PIR) motion detection technology.
- .2 Relay rating: 24 V dc.
- .3 Adjustable time delay: 30 seconds to 30 minutes.
- .4 Operating conditions:
  - .1 Temperature: 0 to 40 °C.
  - .2 Relative humidity: 0 to 90%, non-condensing.

.2 Wall-Mounting Applications:

- .1 For mounting on standard electrical box, complete with override button.
- .2 Motion detection coverage: 180 degrees.

.3 Ceiling-Mounting Applications:

- .1 Dual-type sensors combining PIR and ultrasonic technologies.
- .2 Low-profile, flush-mounted housing.
- .3 Motion detection coverage: 360 degrees.
- .4 Adjustable coverage sensitivity.

## 2.7 MULTIPOINT ROOM SENSORS

.1 Microprocessor-based room thermostat/sensor combining multiple built-in sensors in an integrated housing to measure multiple environmental conditions simultaneously.

.2 Enclosure: Plastic housing, with separate mounting base for wall-mounting applications and wiring screw terminals.

.3 User Interface: Blank cover

.4 Operating Conditions:

- .1 Temperature: 0 to 40 °C.
- .2 Relative humidity: 0 to 90%, non-condensing.

.5 Output:

- .1 Individual analog output for each sensor channel: Field-selectable.
- .2 Protocol based: Sensor data points are shared directly to its connected building automation controller using a compatible communication protocol.

.6 Sensor Requirements:

- .1 Temperature: RTD or thermistor type with measurement range of 0 to 50 °C.
  - .1 Minimum accuracy: ± 0.3 °C.
  - .2 Resolution: ± 0.1 °C.
- .2 Humidity: Polymer capacitive type with measurement range of 0 to 95% RH.
  - .1 Accuracy: Minimum ± 3% RH over a range of 10 to 80% RH.
  - .2 Resolution: ± 1% RH.

.3 Carbon Dioxide ($CO_2$): NDIR type with self-calibration algorithm.

.1 Measurement range: 0 to 2000 ppm.

.2 Accuracy: Minimum ± 30 ppm over detection range.

.4 Motion detection: PIR technology.

## 2.8 DIFFERENTIAL PRESSURE SENSORS

.1 General:

.1 Combined sensor and transmitter measuring pressure.

.2 Internal materials: Suitable for continuous contact with industrial standard instrument air, compressed air, water, and steam, as required.

.3 Output signal: 4 to 20 mA, proportional to operating range.

.4 Over-pressure input protection to at least twice the rated input pressure.

.5 Output short circuit and open circuit protection.

.2 For Use in Ventilation Systems:

.1 Suitable for positive, negative, and differential pressure measurement.

.2 Integrated zero and span adjustment.

.3 Operating temperature: -15 to 65 °C.

.4 Accuracy: ± 1% of full-scale output.

.5 Combined non-linearity, repeatability, and hysteresis effects: Maximum ± 1.2% of full-scale output over entire range.

.6 Temperature effects: Maximum ± 0.1% full-scale per 1°C.

.7 Enclosure: Type 4 enclosures in accordance with CSA C22.1, with NPT conduit connection.

.8 Integrated LCD display when used in filter monitoring applications.

.3 For Room Pressurization Applications:

.1 Integrated zero and span adjustment.

.2 Operating temperature: -15 to 65 °C.

.3 Accuracy: ± 0.25% full scale.

.4 Combined non-linearity, repeatability, and hysteresis effects: Maximum ± 0.5% of full-scale output over entire range.

.5 Temperature effects: Maximum ± 0.1% full-scale per 1°C.

.6 Stability: 0.1% of full scale.

.7 Enclosure: Type 4 enclosures in accordance with CSA C22.1.

.8 Sensing point: Provide a stainless steel snubber plate for through-wall or through-ceiling measurement in the space.

.4 For Use in Hydronic Systems:

.1 Wet-to-wet differential pressure transducer.

.2 Integrated zero and span adjustment.

.3 Operating temperature: -20 to 85 °C.

.4 Accuracy: ± 1% full scale.

.5 Temperature effects: 1%/1°C and maximum ± 2% full-scale over a 50°C range.

.6 Burst pressure: Five times rated pressure.

.7 Enclosure: Die-cast aluminum, powder coated, Type 4 enclosures in accordance with CSA C22.1, with watertight fittings and LCD display.

.8 Manifold: Five-valve machined brass manifold for isolation and maintenance of pressure transmitter.

## 2.9 STATIC PRESSURE SENSORS

.1 Static pressure sensing tips designed for measuring static pressure in ducts or pressure drop across filters or coils.

.2 Requirements:

.1 Stainless steel construction with mounting flange and rubber gasket.

.2 Multipoint element with self-averaging manifold.

.3 Select sensors for expected air flow velocities.

## 2.10 AIRFLOW MEASURING STATION

.1 Thermal Dispersion Type:

.1 Each station includes a microprocessor-based transmitter and a probe array consisting of one or more multipoint measuring probes, depending on the application.

.2 Measurement:

.1 Temperature compensated air velocity measurement.

.2 Independent measuring points with sensor averaging calculations.

.3 Sensors: Hermetically-sealed thermistor probe.

.3 Accuracy:

.1 Airflow measurement: ± 2% of reading.

.2 Temperature measurement: ± 0.1 °C.

.3 NIST traceable with certification.

.4 Output: Dual isolated analog outputs for airflow and temperature measurements, field-configurable for 4 to 20 mA or 0 to 10 V dc.

.5 User interface: Backlit LCD display and keypad to show measurement values and perform diagnostics and configuration.

.6 Enclosure: Type 4X enclosure in accordance with CSA C22.1, with NPT conduit connection.

.7 For installation on fan inlets:

.1 Probe array: Includes one multipoint measuring probe for each fan inlet.

.2 Each measuring probe to include a minimum of two sensors.

.3 Mounting brackets: Adjustable stainless steel brackets for mounting measuring probes inside the fan inlet bell.

.4 Calibrated Range: 0 to 50 m/s.

.5 Operating conditions:

.1 Temperature: -25 to 50 °C.

.2 Relative humidity: 0 to 99%, non-condensing.

.8 For duct mounting applications:

.1 Probe array: Quantity of multipoint measuring probes and sensor density based on manufacturer's recommendations for the application.

.2 Calibrated Range: 0 to 25 m/s.

.3 Operating conditions:

.1 Temperature: -25 to 50 °C

.2 Relative humidity: 0 to 99%, non-condensing.

.2 Pitot Traverse Station Type:

.1 Multipoint self averaging pitot traverse station consisting of multiple total and static pressure sensors.

.2 Construction: Copper sensing manifolds with welded galvanized casing and connection flanges for in-duct mounting.

.3 Configuration: Rectangular or circular.

.4 Calibrated Range: 2 to 20 m/s.

.5 Accuracy: ± 2% of actual velocity and ± 0.25% repeatability tested in accordance with ANSI/AMCA Standard 610.

.6 Operating conditions:

.1 Temperature: -25 to 50 °C.

.2 Relative humidity: 0 to 99%, non-condensing.

.7 Transmitter: Ultra-low differential pressure transmitter designed to read total and static pressures from an airflow station and produce an output linear and scaled for air volume or velocity.

.1 Microprocessor-based transmitter with LCD display, signal noise filter, and automatic re-zeroing circuit.

.2 Output signal: Field-configurable for 4 to 20 mA or 0 to 10 V dc.

## 2.11 PRESSURE AND DIFFERENTIAL PRESSURE SWITCHES

.1 Requirements:

.1 Internal materials: Suitable for continuous contact with compressed air, water, and steam, as required.

.2 Adjustable setpoint and differential.

.3 Switch: Snap action type, rated at 24 V dc.

.4 Switch assembly: Operate and reset automatically when conditions return to normal. Over-pressure input protection to at least twice rated input pressure.

.5 Accuracy: Within 2% repetitive switching.

.6 Provide switches with isolation valve and snubber, where required by authority having jurisdiction, between sensor and pressure source.

.7 Switches on steam and high temperature hot water service: Provide pigtail syphon.

## 2.12 OUTDOOR TEMPERATURE/HUMIDITY SENSORS

.1 General:

.1 Microprocessor-based transmitter combining temperature and humidity measurement in a single device.

.2 Output: Dual isolated analog outputs for temperature and humidity measurements, field-configurable for 4 to 20 mA or 0 to 10 V dc.

.3 Connections: Integrated weatherproof connectors.

.4 Complete kit with radiation shield and mounting accessories for installation on exterior wall.

.2 Temperature Probes: Calibrated range for -40 to 50 °C with an accuracy of ± 2 °C.

.3 Humidity Probes: Calibrated range for 0 to 100% RH with a minimum accuracy of ± 1% RH over the 10 to 90% RH range.

## 2.13 AIR PRESSURE GAUGES

.1 Diameter: Minimum 38 mm.

.2 Range: Zero to two times operating pressure of measured pressure media or nearest standard range.

## 2.14 ELECTROMECHANICAL RELAYS

.1 Double pole double throw (DPDT) plug-in type with termination base.

.2 Coils: Rated for 24 V dc.

.1 Provide transformer for other voltages.

.3 Contacts: Rated at 5 A at 120 V ac.

.4 Relay to have visual status indication, test button, and hold-on clips.

## 2.22 SOLID STATE RELAYS

.1 General:

.1 Plug-in type with connection socket suitable for DIN-rail mounting.

.2 Operating temperatures: -20 to 70 °C.

.3 Relay to have visual status indication, test button, and hold-on clips.

.4 CSA certified.

.5 Input/output isolation: 4000 V ac at 50/60 Hz for 1 second maximum duration.

.2 Input:

.1 Control voltage: 3 to 32 V dc.

.2 Drop out voltage: 1 V dc.

.3 Output:

.1 Load voltage: Rated for 100 to 240 V ac or 4 to 48 V dc to suit application.

.2 Load current: Rated for minimum 3 A at 40°C.

### 2.23 CURRENT TRANSDUCERS

.1 Combined sensor/transducer, to measure line current and produce proportional signal in one of following ranges:

.1 4-20 mA; or

.2 0-10 V dc.

.2 Isolation: 600 V ac rms.
.3 Induced sensor power.
.4 Accuracy: ± 2% of full scale.
.5 Solid core with adjustable mounting bracket for installation inside motor controls.

### 2.24 CURRENT SENSING RELAYS

.1 Suitable to detect belt loss or motor failure.
.2 Trip point adjustment, output status LED.
.3 Solid core for easy installation.
.4 Induced sensor power.
.5 Relay contacts: Capable of handling 0.5 A at 30 V ac/dc. Output to be N/O solid state.
.6 Suitable for single or three-phase monitoring.

.1 Three-phase applications: Provide discrimination between phases.

### 2.27 TRANSFORMERS

.1 In accordance with IEEE C57.13 and:

.1 Class B single phase control transformer, closed type.

.2 Protection: Complete with fuse holder and fuse or circuit breaker.

.3 Power rating: Volt-ampere (VA) power capacity minimum 20% greater than the rated charge to be connected.

### 2.28 PANELS

.1 Cabinet type, Type 1 enclosures in accordance with CSA C22.1.
.2 Front Door: Key-lockable, mounted on hinges, removeable for easier access.
.3 Interior mounting plate.
.4 Accessories:

.1 Wiring raceways: Provide raceways to organize wiring inside panel.

.2 Terminal blocks: Provide terminal blocks to complete wiring connections inside panel.

.1 Modular type, DIN-rail mounted, with screw-type connections.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

.1 Install equipment and components to allow manufacturer and CSA labels to be visible and legible after

commissioning is complete.

.2 Install field control devices in accordance with manufacturer's recommended methods, procedures, and instructions.

.3 Maintain electrolytic isolation when dissimilar metals come into contact.

.4 Support field-mounted panels, transmitters, and sensors on pipe stands or channel brackets.

.1 Humidity transmitters: Place duct mounted sensors so that sensing element is in air flow in duct.

.5 Firestopping: Provide space for fire stopping in accordance with Section 07 84 00 – Firestopping. Maintain fire rating integrity.

.6 Electrical:

.1 Install in accordance with Section 26 05 00 – Common Work Results for Electrical and Section 25 05 00 – Common Work Results for Integrated Automation.

.2 Terminate wires with screw terminal type connectors suitable for wire size and number of terminations.

### 3.3 TEMPERATURE AND HUMIDITY SENSORS

.1 Stabilize for minimum field adjustments and calibrations.

.2 Install readily accessible and adaptable to each type of application for easy replacement and servicing without special tools or skills.

.3 Outdoor Installation:

.1 Protect from solar radiation and wind effects by non-corroding shields.

.4 Duct Installations:

.1 Install duct in areas with adequate air circulation.

.2 Locate within sensor vibration and velocity limits.

.3 Securely mount extended surface sensor used to sense average temperature

.4 Thermally isolate elements from brackets and supports to respond to air temperature only.

.5 Support sensor element separately from coils and filter racks.

.5 Averaging Duct Type Temperature Sensors:

.1 Install averaging element horizontally across the ductwork starting 300 mm from top of ductwork.

.1 Each additional horizontal run to be maximum 300 mm from one above.

.2 Continue until complete cross-sectional area of ductwork is covered.

.3 Use multiple sensors where single sensor does not meet required coverage.

.2 Wire multiple sensors in series for low temperature protection applications.

.3 Wire multiple sensors separately for temperature measurement.

.4 Use software averaging algorithm to derive overall average for control purposes.

.6 Thermowells:

.1 Include thermowells in piping installations.

.2 Locate well in elbow where pipe diameter is less than well insertion length.

.3 Thermowell to restrict flow by maximum 30%.

.4 Use thermal conducting paste inside wells.

### 3.4 PANELS

.1 Provide for conduit and tubing entry from top, bottom, or sides.
.2 Locate wiring and tubing inside panels in trays or individually clipped to panel back.
.3 Identify wiring and conduit clearly.

### 3.5 PRESSURE AND DIFFERENTIAL PRESSURE SWITCHES AND SENSORS

.1 Install isolation valves and snubbers on sensors between sensor and pressure source, where permitted by the codes specified in Section 01 41 00 – Regulatory Requirements.

.1 Protect sensing elements on steam and high temperature hot water service with pigtail syphon between valve and sensor.

### 3.6 CURRENT TO PRESSURE (I/P) TRANSDUCERS

.1 Install air pressure gauges on outlets of each transducer.
.2 Follow manufacturer's recommendations for wiring. Verify electrical connections and signal integrity.

### 3.7 AIR PRESSURE GAUGES

.1 Install pressure gauges on pneumatic devices, I/P, pilot positioners, motor operators, switches, relays, valves, damper operators, and valve actuators.
.2 Install pressure gauge on output of auxiliary cabinet pneumatic devices.

### 3.8 IDENTIFICATION

.1 Identify field devices in accordance with Section 25 05 53 – Identification for Integrated Automation.

### 3.9 AIR FLOW MEASURING STATIONS

.1 Protect air flow measuring assembly until cleaning of ducts is completed.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 SUMMARY

.1 Section includes:

- .1 Damper operators.
- .2 Damper actuators.
- .3 Control valves.
- .4 Valve actuators.
- .5 Associated controls.

### 1.2 RELATED REQUIREMENTS

.1 Section 23 05 00 – Common Work Results for HVAC
.2 Section 25 05 00 - Common Work Results for Integrated Automation
.3 Section 25 05 53 - Identification for Integrated Automation
.4 Section 26 05 00 - Common Work Results for Electrical

### 1.3 ABBREVIATIONS AND ACRONYMS

.1 EPDM: Ethylene propylene diene monomer.
.2 N/C: Normally closed.
.3 N/O: Normally open.
.4 NPT: National pipe thread.
.5 NPS: Nominal pipe size.
.6 PTFE: Polytetrafluoroethylene.
.7 RTFE: Reinforced polytetrafluoroethylene.
.8 SPDT: Single pole, double throw.

### 1.4 REFERENCE STANDARDS

.1 American Society of Mechanical Engineers (ASME):

- .1 ASME/ANSI B16 Series, Standards for Pipes, Fittings and Valves

.2 CSA Group (CSA):

- .1 CSA C22.1-18, Canadian Electrical Code, Part I (24th edition), Safety Standard for Electrical Installations

.2 Fluid Controls Institute (FCI):

- .1 ANSI/FCI 70-2-2021, Standard for Control Valve Seat Leakage Testing

.2 National Electrical Manufacturers Association (NEMA):

- .1 ANSI/NEMA 250-2020, Enclosures for Electrical Equipment (1000 Volts Maximum)

### 1.5 ADMINISTRATIVE REQUIREMENTS

.1 Coordination:

- .1 Coordinate with Section 23 05 00 – Common Work Results for HVAC for requirements related to administration and execution of heating, ventilating, and air conditioning (HVAC) work.
- .2 Coordinate with Division 23 for damper actuator types, mounting, and sizing requirements.

.3 Coordinate with Division 23 for location of control valves on site and requirements for operation and maintenance activities.

.4 Coordinate with Section 25 05 00 - Common Work Results for Integrated Automation for additional requirements related to administration and execution of work of this section.

.2 Pre-installation meetings: Conduct a site meeting in accordance with Section 01 31 19 – Project Meetings and attended by the Consultant and related Subcontractors to:

.1 Verify project requirements.

.2 Coordinate with other Subcontractors.

.3 Review manufacturer's instructions and warranty requirements.

### 1.6 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 – Submittal Procedures and Section 25 05 00 – Common Work Results for Integrated Automation.

.2 Product Data: Product literature and data sheets, including product characteristics, performance criteria, physical sizes, and limitations.

.1 Submit product data for:

.1 Damper actuators.

.2 Valves.

.3 Controls.

.3 Shop Drawings:

.1 Submit Equipment Schedules for detailed Shop Drawing review. Include:

.1 Damper Actuator Schedule.

.2 Control Valve Schedule.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE/DESIGN CRITERIA

.1 Provide control devices, for each category, of same type and manufacturer.
.2 Operating conditions: 0°C to 32°C with 10% to 90% relative humidity (RH) (non-condensing).
.3 Terminations: Use standard conduit box with slot screwdriver compression connector block.
.4 Transmitters and sensors: Unaffected by external transmitters, including walkie talkies.
.5 Account for hysteresis, relaxation time, and maximum and minimum limits in sensor and control applications.
.6 Outdoor installations: Use weatherproof construction in type 4 enclosures in accordance with CSA C22.1.
.7 Devices installed in user-occupied spaces: Maximum noise criteria (NC) of 35. Provide devices that will not generate noise detectable above space ambient conditions.

### 2.3 ELECTRONIC DAMPER ACTUATORS

.1 Proportional or on/off as indicated.
.2 Mounting: Direct-mount type complete with U-bolt clamp and anti-rotation bracket.

.1 Other applications: Provide additional brackets, adaptors, and accessories required for coupling actuator to damper shaft.

.3 Spring return for fail-safe in N/O or N/C position as indicated.
.4 Operator:

.1 Size to control dampers against maximum pressure and dynamic closing/opening pressure, whichever is greater.

.2 Torque capacity: Provide actuators to achieve at least 30% greater capacity than calculated torque requirements for application.

.5 Power supply: 24 V ac/V dc.

.6 Control signal: 0-10 V dc or 4-20 mA for proportional type actuators.

.7 Auxiliary switches:

.1 Provide actuator with built-in SPDT auxiliary switch where indicated.

.2 Ratings: To suit application.

.8 Rotation runtime:

.1 Damper actuator to drive damper from fully open to fully closed position in less than 120 seconds.

.2 Fast-running actuators: Provide special application damper actuator with capacity to fully open or close damper in less than 10 seconds where indicated.

.9 Air terminal unit applications:

.1 Proportional type only. Floating-point can be used as an alternative if position feedback is included.

.2 Fail to last position.

.3 Torque capacity: Select actuators to achieve at least 15% greater capacity than calculated torque requirements for application.

## 2.4 CONTROL VALVES

.1 General:

.1 Flow characteristic as indicated on Control Valve Schedule: Equal percentage, linear, quick opening.

.2 Flow factor (Kv) as indicated on Control Valve Schedule.

.3 Unless otherwise noted in the Control Valve Schedule, all control valves to include spring return for fail-safe in N/O or N/C position as indicated except zone heating valves.

.4 Leakage rating: To ANSI/FCI 70-2, class IV, 0.01% of fully open valve capacity.

.2 Body: Globe style Characterized ball type.

.1 Packing easily replaceable.

.2 Stem: Stainless steel.

.3 Plug and seat: Stainless steel Brass Bronze.

.4 Operating temperature range: -7°C to 120°C.

.5 NPS 2 and under:

.1 Screwed NPT tapered female connections.

.2 Valves: To ASME/ANSI B16 series, class 250.

.3 Rangeability: Minimum 50:1.

.6 NPS 2.5 and larger:

.1 Flanged connections.

.2 Valves: To ASME/ANSI B16 series, class 150 or 250.

.3 Rangeability: Minimum 100:1.

.3 Butterfly valves:

.1 Size: NPS 2 and larger.

.2 End connections to suit class 150 flanges in accordance with ASME/ANSI B16 series.

.3 Body:

.1 For chilled water service: To ASME/ANSI B16 series, class 150, cast iron lug wafer type.

.2 For steam and heating water services: To ASME/ANSI B16 series, class 150, carbon steel lug wafer type.

.4 Extended stem neck to provide adequate clearance for flanges and insulation.

.5 Pressure limit: Bubble-tight sealing to 170 kPa.

.6 Disc/vane: 316 stainless steel aluminum bronze.

.7 Seat:

.1 For chilled water services: PTFE EPDM.

.2 For steam and heating water services: PTFE RTFE.

.8 Stem: 316 stainless steel.

.9 Maximum pressure drop as indicated on Control Valve Schedule: Pressure drop not to exceed one half of inlet pressure.

.10 Valves to be provided complete with mounting plate for installation of valve actuator.

.4 Ball valves:

.1 For on/off type control on connections NPS 2 and under.

.2 Body: Full-port type, brass bronze stainless steel construction.

.3 End connections: Screwed NPT female connections.

.4 Stem: Stainless steel.

.5 Ball: Stainless steel Brass.

.6 Packing and seat: PTFE EPDM.

.7 Operating temperature range: -15°C to 130°C.

## 2.5 PRESSURE-INDEPENDANT CONTROL VALVES

.1 For terminal heating and terminal cooling applications with pipe connections of NPS 2 or under.

.2 Complete control valve packages for pressure-independent control, including:

.1 motorized control valves;

.2 field-adjustable flow limiters;

.3 automatic pressure regulators; and

.4 pair of pressure/temperature (P/T) ports for field measurement.

.3 Body: Globe style Characterized ball type, brass construction, NPT screwed connections, pressure-temperature rated to class 150 in accordance with ASME/ANSI B16 series.

.4 Stem: Stainless steel.
.5 Plug and seat: Stainless steel Brass plug/ball with PTFE or EPDM seat and packing, with class IV leakage rating in accordance with ANSI/FCI 70-2.
.6 Flow characteristics: Equal percentage Linear.
.7 Flow control accuracy: ±5% within operating pressure range.
.8 Operating pressure range: 35 kPa to 345 kPa differential pressure.
.9 Operating temperature range: 1°C to 120°C.
.10 Electronic actuator: Spring return to fail-safe position as indicated, proportional 4-20 mA 0-10 V dc control signal, scaled visual position indicator and manual override mechanism.

### 2.8 ELECTRONIC/ELECTRIC VALVE ACTUATORS

.1 Proportional or on/off type, as required to meet control sequence.
.2 Positioning time: To suit application, maximum 90 seconds.
.3 Fail to normal position as indicated.
.4 Scale or dial indication of actual control valve position.
.5 Manual override mechanism.
.6 Control signals:

- .1 For proportional control: 0-10 V dc 4-20 mA.
- .2 For on/off control: 24 V ac/V dc.

.7 Size actuator to meet shut-off pressure and performance requirements of control valve. Select actuator with at least 25% greater torque than theoretical requirements.
.8 Auxiliary switches:

- .1 Provide actuator with built-in SPDT auxiliary switch where indicated.
- .2 Ratings: To suit application.

.9 For interior and perimeter terminal heating and cooling applications, floating control actuators are acceptable.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

.1 Install operator and actuator devices in accordance with manufacturers' instructions.
.2 Install equipment and components with visible and legible manufacturer and CSA labels post-commissioning.
.3 Electrical:

- .1 Complete installation in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Terminate wires with screw terminal type connectors suitable for wire size and number of terminations.

.4 Pneumatics: Provide pneumatic tubing, valves, and fittings for actuators and operator devices in accordance with Section 23 09 43 - Pneumatic Control System for HVAC.

### 3.2 IDENTIFICATION

.1 Identify field devices in accordance with Section 25 05 53 - Identification for Integrated Automation.

### 3.4 CLOSEOUT ACTIVITIES

.1 Provide demonstration and training for each type of actuator, operator, and ancillary component in accordance with Section 01 79 00 – Demonstration and Training and Section 25 05 00 – Common Work Results for Integrated Automation.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 SUMMARY

.1 Section Includes:

- .1 Requirements for building automation controllers and deployment of a distributed-type automation system to support integrated automation and perform direct control, supervision, and management of equipment related to:
  - .1 HVAC.
- .2 Description of equipment and installation for various types of building automation controllers, including:
  - .1 NMC.
  - .2 SMC.
  - .3 CAC.
- .3 ASC requirements to deploy a network of building automation controllers as a distributed control system, in accordance with ANSI/ASHRAE Standard 135.

### 1.2 RELATED REQUIREMENTS

.1 Section 25 05 00 – Common Work Results for Integrated Automation
.2 Section 25 35 13 – Integrated Automation Actuators and Operators
.3 Section 25 45 00 – Centralized Building Management System
.4 Section 25 70 00 – Integrated Automation Building Systems Integration
.5 Section 25 90 00 – Integrated Automation Control Sequences

### 1.3 ABBREVIATIONS AND ACRONYMS

.1 AI: Analog input.
.2 AO: Analog output.
.3 ASC: Application-specific controller.
.4 BC: Building controller.
.5 BI: Binary input.
.6 BO: Binary output.
.7 CAC: Custom application controller.
.8 CDL: Control description logic.
.9 DDC: Direct digital control.
.10 HMI: Human-machine interface.
.11 I/O: Input/output.
.12 IP: Internet protocol.
.13 NMC: Network management controller.
.14 OWS: Operator workstation.
.15 PICS: Protocol implementation conformance statement.
.16 PID: Proportional-integral-derivative.
.17 SMC: System management controller.
.18 TCP: Transmission control protocol.
.19 UDP: User datagram protocol.
.20 UI: Universal input.
.21 UO: Universal output.
.22 UPS: Uninterruptible power supply.

## 1.4 DEFINITIONS

.1 Ethernet-IP Network: Network based on IEEE 802 standards and the internet protocol suite, to support UDP and TCP as transport layer protocols.

.2 Native BACnet: A feature attributed to devices that were designed and constructed primarily to function with the BACnet protocol in accordance with ANSI/ASHRAE Standard 135. With Native BACnet devices, the BACnet protocol is directly embedded and additional gateways or drivers are not required to enable communication with other BACnet-compliant products.

.3 Product Line: For the purpose of this section, a building automation controller Product Line is defined as a group of building controllers that were specifically developed to function together. Building controllers grouped under a Product Line use the same software, accessories, and tools to:

.1 Configure, edit, and view building controller parameters and data.

.2 Create and modify programmable logic resident in building controllers.

.3 Run diagnostics on building controller performance and device status.

.4 System Architecture Diagram: Network diagram of the whole integrated automation system showing networking equipment, automation components, building automation controllers, and the networking links between all system devices, as described in Section 25 05 00 – Common Work Results for Integrated Automation.

## 1.5 REFERENCE STANDARDS

.1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE):

.1 ANSI/ASHRAE Standard 135-2020, BACnet – A Data Communication Protocol for Building Automation and Control Networks

.2 CSA Group (CSA):

.1 CSA C22.1-18, Canadian Electrical Code, Part I (24th Edition), Safety Standard for Electrical Installations

.2 CSA Z317.2:19, Special requirements for heating, ventilation, and air-conditioning (HVAC) systems in health care facilities

.3 Institute of Electrical and Electronics Engineers (IEEE):

.1 IEEE 802 Series, IEEE Standard for Local and Metropolitan Area Networks, latest versions

.4 National Electrical Manufacturers Association (NEMA):

.1 ANSI/NEMA 250-2020, Enclosures for Electrical Equipment (1000 Volts Maximum)

.5 Telecommunications Industry Association (TIA):

.1 TIA/EIA-568-B.2-2001, Commercial Building Telecommunications Cabling Standard, Part 2: Balanced Twisted-Pair Cabling Components

## 1.6 ADMINISTRATIVE REQUIREMENTS

.1 Coordination:

.1 ASCs: Coordinate with Division 23 for selecting ASCs to integrate the controller's I/O requirements and mounting arrangement with the proposed equipment for terminal equipment applications (variable air volume systems (VAVs), fan coil units, etc.).

.2 Integrated Automation Meetings:

.1 Before submitting Shop Drawings, organize meetings with affected trades to coordinate third-party equipment interface details and integration of building systems with the building automation controllers.

.2 Coordinate meetings in accordance with Section 25 70 00 – Integrated Automation Building Systems Integration. Include:

.1 Data communication details: Protocol, data rate, wiring requirements;

.2 List of data points available at communication interface; and

.3 Requirements for special network accessories.

## 1.7 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 – Submittal Procedures and Section 25 05 00 – Common Work Results for Integrated Automation.

.2 Product Data: Product literature and data sheets including product characteristics, performance criteria, physical sizes, example warranty documentation, type and size of memory, local archiving capacities, and limitations.

.3 Shop Drawings:

.1 System Architecture Diagram:

.1 Include in the diagram:

.1 List of controllers, including quantities and point contents.

.2 Supervisory type controllers included in the Project.

.3 All secondary communication buses with listing of subordinate devices.

.4 Certificates:

.1 BACnet Certification: Submit proof of BACnet BTL-listing and BACnet PICS for each type of building controller proposed.

.5 Test Reports: Report showing controller performance of all supervisory type controllers (NMCs, SMCs) at the end of the Project.

.1 Include:

.1 Current controller load: CPU usage (in%) or database memory usage (in kB or%).

.2 Current non-volatile memory usage for trending (in kB or%).

.3 Controller scan rate.

.6 Manufacturer's Instructions:

.1 Special delivery, storage, and handling requirements.

.2 Installation instructions.

.3 Recommended sequencing.

## 1.8 QUALITY ASSURANCE

.1 Qualifications:

.1 Products specified in this section to be installed and configured by the manufacturer or an authorized installer.

.2 Work specified in this section to be performed by company with 3 years of specialized documented experience.

.3 Integration Work: Integration specialists to perform work to interface controllers with third-party equipment.

.1 Integration specialists: Company experienced in communication protocols used to perform the integration with 3 years of documented experience.

## PART 2 - PRODUCTS

### 2.1 EXISTING PRODUCTS

.1 Select new materials/equipment for compatibility with existing systems, in accordance with Section 25 05 00 – Common Work Results for Integrated Automation.

### 2.2 MANUFACTURERS

.1 Provide building automation controllers from a single manufacturer and Product Line.

.1 Request written acceptance from the Consultant to use materials of different Product Lines.

### 2.3 SYSTEM DESCRIPTION

.1 Provide network of controllers comprised of NMCs, SMCs, CACs, or ASCs, as indicated in the System Architecture Diagram, to support building systems and associated sequences of operations detailed in this section.

.1 Provide sufficient controllers to meet the requirements of this section.

.2 Controllers: Stand-alone intelligent control units.

.1 Incorporate programmable microprocessor, non-volatile program memory, RAM, and power supplies as required to perform specified functions.

.2 Incorporate communication interface ports to exchange information with other controllers and systems connected the integrated automation network.

.3 Logic and control functions to use primary inputs and outputs connected directly to the controller's onboard I/O field terminations or slave devices and without need to interact with other controllers.

.1 Secondary inputs used for optimization such as outdoor air temperature may be located in other controllers.

.3 System Architecture: Controllers to form part of a distributed type automation system. Each controller to operate independently, while data communication is primarily used for supervisory and optimization functions.

.1 Equip controllers with I/O modules to perform direct control of their associated equipment/system using DDC by interfacing with field instrumentation and control devices.

.2 Equip controllers with primary and secondary communication ports (NMCs, SMCs) to play a supervisory role and:

.1 Integrate subordinate devices residing on secondary level networks and manage data exchange between subordinate devices and components residing on the primary level Ethernet-IP Network.

.2 Process data of subordinate devices in order to coordinate optimization routines and perform whole system control optimization.

.3 Communicate controllers with a centralized building management system, as described in Section 25 45 00 – Centralized Building Management System, used to:

.1 Provide an HMI to view, control, and supervise building automation controller operation.

.2 Manage building operation functions such as data archiving, trending, scheduling, and alarming.

.4 Communication Levels: Perform data communication between controllers in two distinct levels.

.4 Primary level Ethernet-IP Network: Used to establish peer-to-peer communication between IP-based controllers and other components/systems forming part of the integrated automation architecture.

.5 Secondary level communication buses: Used to connect subordinate devices directly to a supervisory type controller (NMC, SMC) to perform local communication, and to enable data exchange with the primary level Ethernet-IP Network.

## 2.4 PERFORMANCE/DESIGN CRITERIA

.1 Provide network of building controllers to:

.1 support scanning of connected AI and BI for detection of change of value and processing detection of alarm conditions;

.2 perform on-off digital control of connected points, including resulting required states generated through programmable logic output;

.3 perform analog control using programmable logic, (including PID) with adjustable dead bands and deviation alarms;

.4 control systems as described in Section 25 90 00 – Integrated Automation Control Sequences; and

.5 support execution of optimization routines as listed in this section.

.2 Conduct communication of building automation controllers using the BACnet data communication protocol, in accordance with ANSI/ASHRAE Standard 135.

.1 Operate communication of controllers residing on the primary Ethernet-IP Network in accordance with the BACnet/IP protocol.

.2 Operate communication on secondary communications buses in accordance with the BACnet MS/TP protocol.

.1 Provide support for other data communications protocols as indicated in the System Architecture Diagram or as required through the preliminary design review.

.3 BACnet conformance: Each controller type (NMC, SMC, CAC, or ASC) to be BTL-listed in accordance with the specified BACnet device profile.

.3 System Operation:

.1 System to use a distributed control architecture. Deploy building controllers to perform operation of local control loops and provide control for a dedicated building system or equipment.

.2 Stand-alone operation: Physical inputs/outputs, control loops, and real-time control functions associated with a system to reside on a single controller.

.1 Each controller operates its system/equipment independently from other controllers in case of communication failure.

.2 Each controller includes the necessary memory and programs to support system control functions independently to maintain control integrity.

.3 Use data exchange between controllers to perform optimization and reset functions.

.1 Data exchange is not intended for inclusion in any real-time control functions.

.3 Use transparent peer-to-peer communication for system architecture, in accordance with the Ethernet standards and the IP suite.

.1 BACnet/IP data communication protocol is prioritized to facilitate data exchange between controllers and with components of the centralized management system.

.2 Use supervisory controllers (NMCs, SMCs) to integrate controllers and third-party devices that use other data communication protocols, to enable data transfer with other BACnet/IP devices.

.4 Supervisory controllers (NMCs, SMCs) maintain communication with their subordinate devices, continue to perform data exchange, and execute optimization routines during communication failure with the primary level Ethernet-IP Network.

.5 Locate controllers strategically by mounting panels directly on, or in proximity of, the equipment/system being controlled.

.4 I/O Interface: Used to electronically interface sensors and control devices to the controller's processor unit.

.1 Build I/O interface in feature of controller or make it available through remote expansion modules connected via a dedicated controller bus. I/O modules to include:

.1 programmed firmware or logic circuits to meet functional and technical requirements;

.2 power supplies for operation of logics devices and associated field equipment;

.3 required communications equipment and wiring (if remote expansion modules are used); and

.4 wiring terminations with conveniently located plug-in type screw terminals.

.2 Leave controlled system in "fail-safe" mode in event of loss of communication with, or failure of, controller.

.3 I/O interface to accept as minimum AI, AO, BI, and BO functions. The use of UI and universal outputs (UO) is also acceptable as long as minimum AI, AO, BI, and BO functions are met.

.4 AI interface equipment:

.1 Convert analog signals to digital format with minimum 12-bit analog-to-digital resolution.

.2 Supply the following input signal types and ranges:

.1 4 to 20 mA;

.2 0 to 10 V dc; and

.3 Resistance temperature detector (RTD) input.

.5 AO interface equipment:

.1 Convert digital data from controller processor to acceptable analog output signals using minimum 8-bit digital-to-analog resolution.

.2 Provide for following output signal types and ranges:

.1 4 to 20 mA; and

.2 0 to 10 V dc.

.6 BI interface equipment:

.1 Able to reliably detect contact change of sensed field contact and transmit condition to controller.

.2 Accept pulsed inputs up to 100 Hz.

.7 BO interface equipment:

.1 Respond to controller processor output, switch respective outputs. Each BO hardware to be capable of switching up to 0.5 A at 24 V ac.

.2 Switch up to 5 A at 220 V ac using optional interface relay.

.8 Provide surge and low-voltage protection for interconnecting wiring connections.

.5 System Capacity: Selection of controllers to meet the following performance criteria.

.1 I/O spare capacities:

.1 For each SMC and CAC: Select controllers with at least 25% spare capacity of each point type to allow for future expansion.

.2 Secondary bus capacities:

.1 For each supervisory controller (NMC, SMC): Limit quantity of subordinate devices residing on a secondary communication bus to 60% of its maximum theoretical capacity, according to manufacturer's literature.

.3 Controller performance:

.1 Equip each supervisory controller (NMC, SMC) with sufficient processing unit and memory.

.1 The controller load (CPU usage or database memory usage) never exceeds 75%.

.2 Maintain a minimum scan rate of 2.

.2 Demonstrate controller performance via controller diagnostic tool at time of project completion.

.4 Trending: Provide sufficient internal memory to each controller to trend and archive all points (physical and logical) associated with the controller for a minimum of 48 hours using a 15 minutes sampling rate.

.1 The supervisory controller (NMC or SMC) to perform trending and archiving in the event application-specific controllers (ASCs) or third-party subordinate devices do not support local trending.

.1 Point count for trending and archiving in the supervisory controller to include points from subordinate devices.

.2 Troubleshooting trends: Provide additional capacity at each SMC to create up to five custom trends, archived for a minimum of 4 hours using a 5-second sampling rate for specific troubleshooting activities.

.3 The centralized management system polls the controllers on a periodic basis to retrieve trending data and perform long term data archiving. The controller buffers trending data locally, in the event of a communication failure, until communication is re-established.

.6 Point Display:

.1 Upon operator's request, controllers to present status of any single 'point','system' or point group, entire 'area', or entire network via the centralized management system (OWS or HMI) as selected by operator.

.1 Display analog values digitally to one decimal place with negative sign as required.

.2 Update displayed analog values and status when new values are received.

.3 Flag points in alarm by blinking, different colour, or other means to differentiate from points not included in alarm.

.4 Updates to be change-of-value (COV)-driven or in case polled not exceeding 10-second intervals.

.7 Point Name and Tag Support:

.1 Controllers to support point naming convention and semantic tagging as defined in Section 25 25 00 – Integrated Automation Interoperability Requirements.

.8 Operational Requirements:

.1 Controllers and associated hardware and software: Operate in conditions of 0 °C to 40 °C and 10% to 90% non-condensing relative humidity.

.1 Operate controllers mounted in exterior enclosures in conditions of -40 °C to 40 °C.

.2 Cabinets: Mount controllers in wall-mounted cabinets with hinged, keyed-alike locked door.

.1 Provide conduit entrance from top, bottom, or sides of panel.

.2 Mounting details acceptable to the Consultant for ceiling mounting.

.3 Mount ASCs in equipment enclosures or separate enclosures.

.4 Cabinets to provide protection from water dripping from above, while allowing sufficient airflow to prevent internal overheating, such as Type 3R enclosures in accordance with CSA C22.1.

## 2.5 NETWORK MANAGEMENT CONTROLLER (NMC)

.1 NMC to coordinate and supervise subordinate devices, and facilitate data exchange between the subordinate devices and a primary Ethernet-IP Network, in accordance with ANSI/ASHRAE Standard 135.

.2 Applications:

.1 Supervisory panel: To coordinate and manage operation of subordinate control devices (CACs, ASCs, third-party controllers, etc.) and to execute optimization routines, such as demand limiting.

.2 Router: To route data between BACnet MS/TP and BACnet/IP networks or between two BACnet/IP networks.

.3 Gateway: To integrate devices operating with data communication protocols other than BACnet.

.3 Characteristics:

.1 Fully programmable: Capability to fully customize the controller's operation and create custom optimization routines for subordinate devices.

.2 Firmware: Native BACnet with capability to support other data communication protocols through selected communication ports.

.1 Capacity to perform firmware upgrades directly through its primary communication interface.

.3 Integrated real-time clock enabling the NMC to operate on a stand-alone basis during a communication failure with other devices residing on primary Ethernet-IP Networks.

.1 Independent operation including trending, alarming, scheduling, and optimization to continue as long as data communication remains operational between the NMC and its subordinate devices.

.4 Super capacitor or battery backup: To maintain power to the real-time clock and protect volatile memory for 72 hours during a power loss.

.4 Memory:

.1 Sufficient onboard memory to store operating system, applications, configuration parameters, device backup, and operations data (alarms, trends, schedules, setpoints, etc.).

.1 Trend log capacity: Sufficient to archive all points associated with the NMC and its subordinate devices for a minimum of 48 hours using a sampling rate of 15 minutes.

.2 Sufficient internal rewritable memory (RAM) for running applications, control programs, and processing operations data.

.5 Communications:

.1 Primary communication interface: Ethernet port, 10/100 Mbps, supporting the BACnet/IP protocol.

.2 Secondary communication ports: four RS-485 ports supporting either the BACnet MS/TP, or Modbus.

.6 Power Supply: 24 V ac.

.7 Certification:

.1 BACnet Conformance: BTL-listed as a B-BC device.

.2 BACnet secure connect: BACnet/SC compliant.

## 2.6 SYSTEM MANAGEMENT CONTROLLER (SMC)

.1 SMC to provide direct control and supervision of main building systems and plant equipment through its I/O interface. Through a secondary communication interface, the SMC can also supervise related subordinate devices to coordinate overall system/plant operation and execute optimization routines.

.2 Applications:

.1 System control: To provide direct control and supervision of main building systems requiring larger quantity of physical points (I/O), such as main air-handling systems, heating/cooling plants, and service water systems.

.2 System management: To integrate subordinate devices related to the system or plant in order to process additional equipment data and coordinate whole system operation. Subordinate devices may include third-party panels (chillers, pumps, meters, humidifiers, etc.) or related terminal equipment (air terminal units).

.3 Mechanical rooms: To consolidate equipment and instrumentation installed in a common service room, or that operate as interrelated systems.

.3 Characteristics:

.1 Fully programmable: Capability to fully customize the controller's operation and programming, and to create custom optimization routines for subordinate devices.

.2 Supervisory type controller specifically designed for real-time multitasking. Ability to perform direct control of field-level equipment and management of subordinate devices simultaneously.

.3 Integration: Performs data exchange with subordinate devices using its built-in secondary communication ports while communicating with other devices on a primary Ethernet-IP Network, in accordance with ANSI/ASHRAE Standard 135.

.4 Firmware: Native BACnet with capability to support other data communication protocols through selected communication ports.

.1 Capacity to perform firmware upgrades directly through its primary communication interface.

.5 Integrated real-time clock enabling the SMC to operate independently during a communication failure.

.1 SMC to continue internal trending, alarming, and scheduling functions.

.2 Optimization routines, trending, alarming, and scheduling functions with subordinate devices to continue as long as data communication remains operational between the SMC and its subordinate devices.

.6 Super capacitor or battery backup: To maintain power to the real-time clock and protect volatile memory for 72 hours during a power loss.

.4 Memory:

.1 Sufficient onboard memory to store operating system, applications, configuration parameters, device backup, and operations data (alarms, trends, schedules, setpoints, etc.).

.1 Trend log capacity: Sufficient to archive all points associated with the SMC and its subordinate devices for a minimum of 48 hours using a sampling rate of 15 minutes.

.2 Sufficient internal rewritable memory (RAM) for running applications, control programs, and processing operations data.

.5 Communication:

.1 Primary communication interface: Ethernet port, 10/100 Mbps, supporting the BACnet/IP protocol.

.2 Secondary communication ports: multiple RS-485 ports supporting either the BACnet MS/TP, or Modbus.

.6 I/O Interface:

.1 Provide direct connection to field instrumentation and control devices through an on-board I/O interface or through remote I/O modules.

.2 Include plug-in terminals to facilitate maintenance and commissioning activities.

.3 Minimum input/output requirements: Ten AIs, six BIs, eight AOs, four BOs.

.7 Power Supply: 24 V ac.

.8 Certification:

.1 BACnet conformance: BTL-listed as a B-BC device.

.2 BACnet secure connect: BACnet/SC compliant

## 2.7 CUSTOM APPLICATION CONTROLLER (CAC)

.1 CAC to provide multiple control functions for generic applications and typical packaged and decentralized equipment related to HVAC, hydronic systems, and electrical systems.

.2 Applications:

.1 System control: To provide direct control and supervision of building systems with limited physical points (I/O) and that do not require coordination of subordinate devices.

.2 Miscellaneous points: General purpose controller to consolidate miscellaneous control points, status, and alarms distributed throughout the space.

.3 Characteristics:

.1 Fully programmable: Capability to fully customize the controller's operation and execution programs.

.2 Firmware: Native BACnet with capacity to perform firmware upgrades directly through its communication interface.

.3 Integrated real-time clock enabling the CAC to operate on a stand-alone basis during a communication failure.

.4 Super capacitor or battery backup: To maintain power to the real-time clock and protect volatile memory for 72 hours during a power loss.

.4 Memory:

.1 Sufficient onboard memory to store operating system, applications, configuration parameters, device backup, and operations data (alarms, trends, schedules, setpoints, etc.).

.2 Sufficient internal rewritable memory (RAM) for running applications, control programs, and processing operations data.

.5 Communication Interface:

.1 Provide one of the following communication interface options in accordance with the System Architecture Diagram.

.1 Ethernet port, minimum 10 Mbps, supporting the BACnet/IP protocol.

.2 RS-485 port, supporting the BACnet MS/TP protocol at a minimum data rate of 76.8 kbps.

.6 I/O Interface:

.1 On-board I/O interface with plug-in terminals for direct connection to field instrumentation and control devices.

.2 Minimum I/O requirements: Four AIs, four BIs, four AOs, four BOs.

.7 Power Supply: 24 V ac.

.8 Certification:

.1 BACnet conformance: BTL-listed as a B-BC or B-AAC device.

## 2.8 APPLICATION-SPECIFIC CONTROLLER (ASC)

.1 Controller designed to provide control functions for specific applications such as air terminal units, fan coil units, heat pumps, and other field equipment.

.2 Applications:

.1 System control: Mounted directly on controlled equipment or in proximity to provide direct control of the equipment.

.3 Characteristics:

.1 Controller programming: Configurable with preprogrammed operating sequences.

.1 The use of configurable programs is acceptable if controller memory can be flashed and replaced by custom programs as required.

.2 Controller programming to be resident on non-volatile memory (Flash or EEPROM) to avoid controller re-programming after a power loss.

.2 Firmware: Native BACnet with capacity to perform firmware upgrades directly through its communication interface.

.3 Controller provided with necessary memory and I/O interface to control the equipment and operate independently of network in case of communication failure.

.4 BACnet/IP Devices:

.1 ASCs using the BACnet/IP protocol communicate directly on the primary Ethernet-IP Network.

.1 Controller equipped with additional non-volatile memory to manage alarms, events, and trends locally.

.2 Trending: Capacity to archive all points residing within the ASC for a minimum of 48 hours using a sampling rate of 15 minutes.

.2 Communication interface:

.3 Provide one of the following communication interfaces in accordance with the System Architecture Diagram.

.1 Dual Ethernet ports: Minimum 10 Mbps, supporting the BACnet/IP protocol in a ring topology.

.3 Power supply: 24 V ac.

.4 BACnet Conformance: BTL-listed as a B-BC or B-AAC device.

.5 I/O Interface:

.1 On-board I/O interface with plug-in terminals for direct connection to field instrumentation and control devices.

.2 Minimum I/O requirements: Controller equipped with sufficient built-in I/O capacity to connect all required field instrumentation and control devices to control its associated system.

.3 Air terminal units:

.1 Damper actuators: Controller equipped with built-in actuator.

.1 Proportional type in accordance with Section 25 35 13 – Integrated Automation Actuators and Operators.

.2 Floating-point type with position feedback in accordance with Section 25 35 13 – Integrated Automation Actuators and Operators.

.2 Airflow sensors: Controller equipped with built-in flow transducer.

.3 Include minimum inputs for the following devices:

.1 Room temperature sensors.

.2 Relative humidity sensors.

.3 Carbon dioxide ($CO_2$) sensors.

.4 Occupancy sensors.

## 2.9 SOFTWARE

.2 Include:

.1 Operating system executive, communications, application programs, operator interface, and systems sequence of operation.

.2 "Firmware" or instructions programmed into non-volatile memory such as flash.

.3 Initial programming of controllers for entire system.

.3 Programming Languages:

.1 Program CDL software using English language or graphical, high level, general control language.

.2 Structure software in modular fashion for simple restructuring of program modules if future software additions or modifications are required.

.1 The use of "GO TO" constructs is not allowed unless acceptable to the Consultant.

.3 Self-documenting programs: Incorporate self-explanatory code, comments, and descriptions in CDLs to document program objectives.

.4 Program Updates:

.1 Program modifications and updates in operational controllers can be performed "live" while minimizing impact on the controlled process. Controllers continue to run other program sections and the only processes affected are directly related to the sections of the programs being modified and updated.

.5 Operator Interface:

.1 Operating and control functions to include:

.1 multi-level password access protection to allow user/manager to limit control at operator workstations;

.2 alarm management: processing and messages;

.3 operator commands;

.4 reports;

.5 displays; and

.6 point identification.

.6 Pseudo or Calculated Points:

.1 Software to provide access to value or status in controller or other networked controllers to define and calculate pseudo points. When current pseudo point value is derived, normal alarm checks are to be performed or value used to totalize.

.2 Inputs and outputs for process: Include data from controllers to permit development of network-wide control strategies. Processes also to permit operator to use results of one process as input to number of other processes (cascading, etc.).

.7 Control Description Logic (CDL):

.1 Capable of generating online project-specific CDLs which are software based, programmed into non-volatile memory and backed up to OWS. Owner to have access to these algorithms for modification or to be able to create new ones and to integrate these into CDLs on BCs from OWS.

.2 Write CDL in high level language that allows algorithms and interlocking programs to be written simply and clearly. Use parameters entered into system (setpoints, etc.) to determine operation of algorithm. Operator to be able to alter operating parameters online from OWS and BCs to tune control loops.

.3 Perform changes to CDL online.

.4 Control logic to have access to values or status of points available to controller, including global or common values, allowing cascading or interlocking control.

.5 Energy optimization routines including enthalpy control, supply temperature reset to be NMC or SMC resident functions and form part of CDL.

.6 Controllers to be able to perform following pre-tested control algorithms:

.1 Two position control.

.2 Proportional-integral-derivative (PID) control.

.3 Automatic loop tuning.

.7 Control software to provide ability to define time between successive starts for each piece of equipment to reduce cycling of motors.

.8 Protect against excessive electrical-demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.

.9 Power fail restart: To verify availability of emergency power upon detection of power failure system, as determined by emergency power transfer switches.

.1 Analyze controlled equipment to determine its appropriate status under emergency power conditions and start or stop equipment accordingly.

.2 Supervisory controllers (NMCs, SMCs) to analyze status of controlled equipment upon resumption of normal power, as determined by emergency power transfer switches, to compare with normal occupancy scheduling, and to turn equipment on/off as necessary to resume normal operation.

.8 Event and Alarm Management: Use management by exception concept for alarm reporting to confirm only principal alarms are reported to OWS.

.1 System to report events that fail to occur and suppress events that occur as direct result of primary event.

.1 Reported events include: Operational temperature alarms limits that are exceeded when main air handler is stopped and fire alarm status when general fire condition shuts down air handlers.

.2 Identify event sequence in sequence of operation.

.9 Energy Management Programs: Include summarizing reports with time stamp indicating sensor details which activated or terminated feature.

.1 Supervisory controllers (NMCs, SMCs) in coordination with subordinate devices to provide the following energy management routines:

.1 Time of day scheduling.

.2 Calendar based scheduling.

.3 Holiday scheduling.

.4 Temporary schedule overrides.

.5 Optimal start/stop.

.6 Night setback control.

.7 Enthalpy (economizer) switchover.

.8 Peak demand limiting.

.9 Temperature compensated load rolling.

.10 Fan speed/flow rate control.

.11 Hot water reset.

.12 Night purge.

.2 Programs to be executed automatically, without need for operator intervention, and flexible enough to allow customization.

.3 Apply programs to equipment and systems as specified or requested by the Consultant.

.10 Function/Event Totalization: Features to provide predefined reports to show daily, weekly, and monthly accumulating totals and to include high rate (time stamped), low rate (time stamped), and accumulation to date for month.

.1 Controllers to accumulate and store automatically run-time for binary input and output points.

.2 Controllers to automatically sample, calculate, and store consumption totals for user-selected analog or binary pulse input-type points.

.3 Controllers to automatically count events (number of times pump is cycled off and on).

.4 Totalization routine to have sampling resolution of maximum 1 minute for analog inputs.

.5 Totalization to provide calculations and storage of accumulations in engineering units (kWh, litres, tonnes, etc.).

.6 Store event totalization records with minimum of 9,999,999 events before reset.

### 2.10 NETWORK CABLING

.1 Ethernet cables to connect controllers using the BACnet/IP protocol

.1 Network connections for IP devices will be terminated in a patch box (RJ45) installed inside each controller cabinet.

.2 Ethernet Patch Cables: Provide patch cables to connect controllers to network consolidation points.

.1 Certified CAT6 cables in accordance with TIA/EIA-568-B.2.

.2 At controller cabinets: 300 to 1000 mm patch cable to connect controller to patch box.

.3 For ASC ring networks: Provide patch cables to interconnect ASCs and connect ring network to patch panel.

.3 Secondary buses: Provide network wiring for all secondary buses connecting supervisory controllers (NMCs, SMCs) to its subordinate devices:

.1 RS-485 wiring: Twisted pair or shielded cable, low-capacitance, selected in accordance with the controller manufacturer's recommendations.

.4 Wiring not routed within conduit: Use FT6 plenum rated cables.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

.1 Install controllers in secure locking enclosures.
.2 Location of controllers to be acceptable to the Consultant.
.3 Provide necessary power from local 120 V branch circuit panel for equipment.
.4 Install tamper locks on breakers of circuit breaker panel.
.5 Secondary Buses:

.1 Install wiring for secondary buses in accordance with Section 25 05 00 – Common Work Results for Integrated Automation.

## 3.2 CONFIGURATION

.1 Configure controllers to ensure the following is standardized throughout the facility:

.1 Device setup: Naming conventions, device addressing, and user permissions;

.2 Object configuration: Point naming conventions, object tagging, and priority arrays;

.3 Minimum trending requirements; and

.4 Local archiving configuration.

## 3.3 SITE QUALITY CONTROL

.1 Site Tests and Inspections:

.1 At the end of the project, execute a diagnostic on each supervisory type controller (NMC, SMC) and generate a report demonstrating the controller's load (CPU usage or database memory usage), non-volatile memory usage (for trend storage), and scan rate meet the performance criteria.

.2 Submit test report in accordance with ACTION AND INFORMATIONAL SUBMITTALS in this section.

**END OF SECTION**

## PART 1- GENERAL

### 1.1 SUMMARY

.1 Section Includes:

.1 Requirements for a Centralized Building Management System (BMS).

.2 Description of the work related to the supply and installation of a Centralized BMS, including:

.1 Requirements for the main operating software and bundle of applications forming part of the Centralized BMS.

.2 Description of the system's interface requirements.

.2 The Centralized BMS provides a "single-seat" approach to building systems management and supports the integration of third-party systems described in other sections, including:

.1 HVAC packaged systems.

### 1.2 RELATED REQUIREMENTS

.1 Section 25 05 00 – Common Work Results for Integrated Automation
.2 Section 25 24 00 - Integrated Automation System Architecture Requirements
.3 Section 25 41 00 – Building Automation Controllers

### 1.3 DEFINITIONS

.1 Centralized Building Management System: Software-based platform that forms part of the integrated automation system. It provides an interface between building operators and the building's automation and control systems (such as building controllers, integrated control devices, and third-party software). It enables a graphical user interface for displaying system data and alarm/event notifications, managing schedules, performing trending, and creating reports.

### 1.4 REFERENCE STANDARDS

.1 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):

.1 ANSI/ASHRAE 135-2020, BACnet – A Data Communication Protocol for Building Automation and Control Networks

.2 Web Hypertext Application Technology Working Group (WHATWG):

.1 HTML Living Standard, current edition

### 1.5 ADMINISTRATIVE REQUIREMENTS

.1 Coordination:

.1 Coordinate with Section 25 24 00 - Integrated Automation System Architecture Requirements for:

.1 server hardware requirements to host the Centralized BMS;

.2 operator interface requirements; and

.3 data storage capacity for system backup and data historian.

.2 Integrated Automation Meetings:

.1 Organize meetings to coordinate interface details between Centralized BMS and third-party systems, in accordance with Section 25 05 00 – Common Work Results for Integrated Automation, including:

.1 requirements for software drivers or licenses to enable communication with third-party system;

.2 requirements for a database interface (for example, Microsoft Open Database Connectivity, Java Database Connectivity); and

.3 expected quantity of data points to interface.

.2 Coordinate systems that will be integrated with the Centralized BMS and form part of a single-seat approach, including:

.1 data naming and tagging conventions;

.2 object sharing properties and priority arrays;

.3 graphics generation and bank of symbols; and

.4 archiving and trending configuration.

### 1.6 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 – Submittal Procedures and 25 05 00 – Common Work Results for Integrated Automation.

.2 Product Data: Product literature and data sheets for system architecture, including product characteristics, performance criteria, compliance with requirement for concurrent number of users, and limitations.

.3 Shop Drawings:

.1 System Architecture Diagram:

.1 Show components of the Centralized BMS, including servers, operator workstation (OWS), human-machine interface (HMI) devices, and data storage equipment.

.4 Certificates:

.1 BACnet Certification: Submit proof of BACnet testing laboratories (BTL)-listing, and BACnet protocol implementation conformance statement (PICS), in accordance with ANSI/ASHRAE 135.

## PART 2- PRODUCTS

### 2.1 MANUFACTURER

.1 Centralized BMS: Provide software and system applications from the same manufacturer and product line as the facility's building automation controllers specified in Section 25 41 00 – Building Automation Controllers.

### 2.2 DESCRIPTION

.1 Centralized BMS: Software-based platform designed to serve as the main interface between building operators and the building's automation and control systems. The platform includes a main operating software and a bundle of system applications used for the following functions:

.1 Interface with facility control systems, including building automation controllers, equipment and systems provided with integrated controls, and third-party software applications.

.2 Supervise and manage control points and objects to perform facility-wide control, automate processes, and perform system optimization.

.3 Perform collection and archival of data from building automation and control devices.

.2 System Architecture: The Centralized BMS is deployed in a Microsoft-Windows environment using the main system architecture specified in Section 25 24 00 – Integrated Automation System Architecture Requirements, which includes:

.1 Server-OWS: Hosts the main operating software and software applications.

.2 Data storage system: Long-term storage of historical data.

.3 Operator work stations: Portable OWS to support building operations and provide a HMI with the Centralized BMS.

.3 Centralized BMS not to be involved in real-time control functions, whether directly, indirectly, or through communication link. Real-time control functions to reside in building automation controllers (network management controllers (NMCs), system management controller (SMCs), centralized access control (CACs), application-specific controllers (ASCs) with peer-to-peer communication occurring at control device level.

.4 Operator functions available from the Centralized BMS:

.1 Ability to view, create, modify, and delete control objects in accordance with user permissions.

.2 Ability to organize points by site, system, equipment, and point type.

.3 Dynamic graphics navigation.

.4 Modify programming in building controllers.

.5 Historian functions.

.6 Optimization via integration (capability to provide inter-system control or actions, for example, load shedding and occupancy control).

.7 Authorized users are able to view, create, modify, and delete graphics, scheduling/event programs, and historical data (trend logs) via the Centralized BMS.

## 2.3 PERFORMANCE/DESIGN CRITERIA

.1 Centralized BMS to communicate with other devices on the primary Ethernet/Internet protocol (IP) network, and:

.1 In accordance with standard Ethernet protocols and the IP suite.

.2 Operate under Windows' latest platform.

.3 Interface with building automation controllers and third-party systems in a transparent manner using the BACnet data communication protocol, in accordance with ANSI/ASHRAE 135.

.4 Include the capability to interface with third-party systems using other open protocols or standard interface applications.

.5 Centralized BMS software to comply with BACnet standards and be BTL-listed as a BACnet OWS device.

.2 System Architecture:

.1 Scalable architecture: Designed to support the addition of new controllers, third-party devices, control objects, HMIs, or third-party software interfaces (for example, application programming interfaces) without affecting the system's main components or requiring major software modifications or upgrades.

.2 Control object: For systems that include licensing restrictions based on points quantity.

.1 Provide license to manage a minimum of 2000 physical points and 8000 logical points.

.2 Provide a license to manage at least 20% spare point capacity (physical and logical) in addition to project requirements.

.1 Logical points to include calculated values, control variables, and data integrated via third-party control devices.

.3 Designed to support a minimum of ten concurrent users.

.3 System Operation:

.1 Centralized BMS, via the site's servers and OWS, to provide a user interface for command entry, information retrieval and display management, alarm management, and database management functions. Software to enable non-programmer operator to easily perform daily routine tasks.

.1 System to perform duplex data transfer with other components of the integrated automation system to enable dynamic graphics display and data management functions.

.2 Centralized BMS failure: In the event of a server failure or communication malfunction, building automation controllers and other control devices to continue to operate in stand-alone mode and archive system data.

.1 System and configuration tools remain accessible in "local mode" via portable OWS.

.2 System to recover status, alarms, and trends from building controllers once components return online.

.3 Multi-user environment: Centralized BMS to support a multi-user and multi-tasking environment, allowing a number of concurrent users to access, display, and modify system data in real time.

.1 Modifications performed on system programs or database via an OWS or at the system servers to be instantaneously updated on a system-wide basis and displayed at all connected operator interfaces.

.4 Performance Standards:

.1 Graphic display: Graphic with 20 dynamic points to display current data within 5 seconds.

.2 Graphic refresh: Graphic with 20 dynamic points to update with current data within 8 seconds.

.3 Object command: Devices to react to command of a binary object within 2 seconds. Devices to begin reacting to command of an analog object within 2 seconds.

.4 Object scan: Data used or displayed at a controller or workstation to have been current within the previous 2 seconds.

.5 Alarm response time: An object that goes into alarm is annunciated at the workstation within 10 seconds.

## 2.4 OPERATING SOFTWARE

.1 Operating Software: Main software platform providing a graphical user interface with the user and access to various system applications such as trending, reporting, alarming, and:

.1 Interfaces with third-party control systems in a transparent manner, using the BACnet protocol or other standard data communication protocols, as indicated in the system network architecture.

.1 Include necessary software, drivers, or interfaces to integrate other data communication protocols indicated.

.2 Provides a multi-tasking type environment that allows the user to run several applications simultaneously. Standard Windows applications to run simultaneously with the Centralized BMS software with the user able to quickly select and switch between multiple applications.

.1 Operator to be able to work in Windows-based software packages, while concurrently annunciating online BMS alarms and monitoring information.

.3 Web operation: Web-based graphical interface that allows users to access the Centralized BMS data via a network connection (Internet, extranet, or Intranet). Functionality of web-based clients to provide same functionality and user interface provided at OWS with installed software.

.4 SQL database: Trending and historical data to be recorded on a Microsoft SQL database, which resides on the system main server.

.5 System to have the capability to perform dynamic backups and restore a valid backup copy.

.2 Web-Based Interface:

.1 Web interface to allow users connected to network to access with a standard web browser all the basic operator functions provided by the operating software, such as access to dynamic graphics, performing commands, and system data viewing.

.2 Browser compatibility:

.1 Web-based interface to operate in compliance with HTML Living Standard, without requiring additional software or add-ons at the client workstation or special configurations at the web browser.

.3 Graphic database to be stored on the system server without specifically requiring any graphics to be stored on client workstations.

.4 Real-time values displayed on a webpage to update automatically without requiring a manual "refresh" of the webpage.

.5 Support for tablets and smartphones:

.1 Software capable of detecting the operator device and automatically adapt the graphical user interface screen and data presentation based on the device screen size and type (smartphone, tablet, computer screen).

.3 Navigation:

.1 Operator interface software to minimize requirements for operator training through the use of user-friendly and interactive graphical applications, online help tools, and a standard Windows environment.

.2 User interface to display relevant information for a selection in multiple panes of a single window without the need for opening multiple overlapping windows on the desktop.

.3 Interface to minimize the use of keyboard through the use of a mouse or similar pointing device, with a "point and click" approach to menu selection and a "drag and drop" approach to inter-application navigation.

.4 Navigation to be user-friendly by using "forward & back" capability between screens and embedded links to graphics, documents, drawings, trends, and schedules, external documents (for example,.docx,.pdf, and.xlsx), or web addresses related to any selected object.

.5 Operator interface software to use user-defined hierarchical view or navigation tree to browse systems, equipment, and areas.

## 2.5 SYSTEM APPLICATIONS

.1 Time Synchronization Module:

.1 System to provide time synchronization of real-time clocks in networked controllers.

.2 System to perform this feature on a regularly scheduled basis and upon operator request.

.2 User Profiles:

.1 Capability to create, define, modify, and delete user accounts and assign various privileges based on the user profile.

.2 User privileges: Assign user privileges to each user account to limit control, display, and database manipulation capabilities based on a minimum of five user profiles:

.1 Guest: No password data access and display only.

.2 Operator level: Full operational commands, including automatic override.

.3 Technician: Database modifications.

.4 Programmer: Database generation.

.5 Highest level: System administration, including password assignment addition and modification.

.3 User preferences: Each user to have the capability to customize the look of their interface and define or change their views and navigation interface according to user privileges.

.4 Operator audit logs: System to maintain user activity logs (time stamped) to record login and operator modifications.

.5 Graphics Display:

.1 Graphic interface to provide user with multiple layered diagrams for site, building in plan view, floor furniture plan view and building systems, overlayed with dynamic data appropriately placed and facilitating direct operator interaction.

.2 Graphic interface to permit operator to start and stop equipment, change set points, modify alarm limits, override system functions and points from graphic system displays by use of mouse or similar pointing device.

.3 Dynamic graphics: Software to display dynamic data using animated graphics and coloured text. Data (temperature, humidity, flow, status) to be shown in actual schematic locations and to be automatically updated to show current values without operator intervention.

.4 Windowing environment to allow user to view several graphics simultaneously for analysis of building operation, system performance, and display of graphic associated with alarm to be viewed without interruption of work in progress.

.5 Provide a complete pre-engineered library of symbols for building systems and generate graphics depicting:

.1 Standard air handling components: Fans, coils, filters, dampers, and variable air volume systems (VAVs).

.2 Complete mechanical system components: Chillers, boilers, and pumps.

.3 Electrical symbols.

.6 Graphics generation: Graphics software application to permit user to create, modify, delete, file, and recall graphics for all systems.

.1 Graphic development, creation, and modification package to use mouse and drawing utility to permit user to:

.1 Modify portion of graphic picture/schematic background.

.2 Delete graphic picture.

.3 Call up and cancel display of graphic picture.

.4 Define symbols.

.5 Position and size symbols.

.6 Define background screens.

.7 Define connecting lines and curves.

.8 Locate, orient, and size descriptive text.

.9 Define and display colours of elements.

.10 Establish correlation between symbols or text and associated system points or other graphic displays.

.7 Sequence of operation:

.1 Provide unique sequence of operation graphic or pop-up window for each graphic that is depicted on OWS.

.2 Provide access to sequence of operation graphic by link button on each system graphic.

.3 Provide translation and a concise explanation of sequence of operation, from control descriptive logic into plain English.

.3 Alarm and Event Management:

.1 Classify alarms as "critical" or "non-critical". Alarms and alarm classifications to be designated by personnel requiring password level.

.2 Critical alarms to provide alarm annunciation through a dedicated display window (activated to foreground on receipt of new alarm or event) of OWS with visual and audible hardware indication.

.1 Alarm message display to include as minimum: Point identifier, date/time of occurrence, and alarm descriptor.

.3 Alarms to be sent to an alarm log for archiving.

.4 Alarm points returning to normal conditions to be annunciated using the same visual indication process and message descriptor as the initial alarm.

.5 Through the alarm log, the user can send alarm reports to a selected alarm printer for printout.

.6 Filters can be applied to the alarm log to search or sort ongoing and acknowledged alarms.

.7 Alarms can be silenced (audible device) from an OWS, by using a silence button in the alarm window or by acknowledging the alarm (provided the user has the proper authorization level).

.8 Non-critical alarms to be only directed to the alarm log and stored, in order of occurrence, at the centralized management system.

.9 System to provide on-screen visual indicator of ongoing alarms to notify the operator of any active unacknowledged alarms.

.10 Operator-editable secondary messages can be assigned on a per point basis to provide specific instructions related to the alarm (message with minimum 480 alphanumeric characters).

.11 Alarm acknowledgement:

.1 Time, date, and operator to be stamped and stored in alarm log.

.2 Prevent the acknowledgment of one alarm from affecting the acknowledgement status of other alarms.

.12 Controller network alarms: System supervision of controllers and communications lines to provide following alarms as minimum:

.1 Controller not responding: Delineate between controller and communication line failure where possible.

.2 Controller responding: Return to normal.

.3 Controller communications bad: High error rate or loss of communication.

.4 Controller communications normal: Return to normal.

.4 Trending Module:

.1 Capacity to create, modify, view, and delete trend logs using BACnet trend log objects.

.1 Trends are archived within the historian module.

.2 Trending module to include display of historical or trend data to OWS screen in XY plot presentation.

.1 Plot utility to display minimum six historical points or six trend points concurrently.

.2 Display output of real time trend data: Display to automatically index to left when window becomes full.

.3 Provide plotting capabilities to display collected data, using the selected value range for the Y-axis and the time/date stamp of collected data for the X-axis.

.3 Control loop plot utility:

.1 Provide a control loop plot utility for analog output (AO) points that can simultaneously plot the measured input value (present value), the present output value, and the AO setpoint.

.2 Operator selectable sampling interval to range from 1 to 20 seconds.

.3 Plotting utility to scroll left as plot reaches right side of display window.

.4 Systems not supporting a separate control loop plot function to provide predefined groups of values. Each group to include values for a single control loop display.

.4 Customized reports:

.1 Provide operator feature to generate customized reports, allowing users to create personalized reports with text and selected points showing point value/state and descriptor.

.2 Reports can be automatically generated in accordance with a schedule program or through a user manual request.

.5 Energy Management:

.1 Provide tools for programming demand limiting strategies, including load shedding and load shifting sequences.

.2 Include tools oriented towards energy data, such as:

.1 Tools to facilitate energy meter integration.

.2 Templates for configuring and displaying metered data and dashboards.

.3 Virtual metering: For ability to create and configure virtual meters in absence of submetering and to estimate energy consumption of systems, devices, or zones using available system inputs.

.4 Tracking of energy performance, including peak demand, baseline, and setting up alarms for energy high/low limits.

.6 Historian Module:

.1 Used to archive alarms, events, operator activities, and historical data of input/output points and calculated values being trended.

.2 Historian database can be exported to a third-party spreadsheet (for example, MS-Excel, CSV format) for data-handling using another application.

.3 Long-term storage:

.1 System to be able to store and archive historical data for a minimum of 5 years.

.2 Coordinate hardware requirements for data storage with Section 25 24 00 – Integrated Automation System Architecture Requirements.

.3 Capability to remount offline archived data.

.4 System to record system activities occurring at OWS or elsewhere within the integrated automation system including:

.1 Alarm/event log:

.1 Data archived for each alarm/event notification, including time-stamp of alarm occurrence, point name, alarm type, value or state, alarm message, and alarm acknowledgement data (operator-stamp and date/time-stamp).

.2 Display data can be selected in accordance with a specific date or timeframe.

.3 Option to filter only critical alarms.

.2 Operator audit log:

.1 To record and store user activity and operator-initiated commands, such as log-in, attempted log-in, modified setpoint, deleted point, alarm acknowledgement, and override command.

.2 Display data can be selected in accordance with a specific date or timeframe.

.3 Each log includes the date/time of action and type of command/activity. Point modifications archiving to include related point name.

.3 Building controller data:

.1 Historical data residing in building controllers (buffer memory) is transferred to the Centralized BMS on an ongoing basis for long-term storage.

.7 Reports:

.1 Reports to include time, day, month, year, report title, and operator's initials.

.2 Software to provide capability to:

.1 Generate and format reports for graphical and numerical display from real time and stored data.

.2 Print and store reports as selected by operator.

.3 Select and assign points used in reports.

.4 Sort output by area and system, as minimum.

.3 Periodic/automatic report:

.1 Generate specified reports automatically, including options of start time and date, interval between reports (hourly, daily, weekly, monthly), and output device.

.2 Software to permit modifying periodic/automatic reporting profile at any time.

.3 Reports to include:

.1 Power demand and duty cycle summary: Refer to application program for details.

.2 Disabled "locked-out" point summary: Include point name and indicate whether it was disabled by system or by operator.

.3 Run time summary: Provide a summary of accumulated running time for selected equipment, including point name, run time to date, and alarm limit setting. Run time to accumulate until individually reset by operator.

.4 Summary of run time alarms: Include point name, run time to date, and alarm limit.

.5 Summary of start/stop schedules: Include start/stop times, days, and point name.

.6 Motor status summary.

.4 Dynamic reports:

.1 System capability to printout or display point object data.

.2 System capability to indicate status at the time of request; when displayed, updated at operator-selected time interval.

.3 Provide operators with the option to select report types by point name or output device. Reports to cover the following point value combinations:

.1 Points accessible from this OWS (total connected for this location) across multiple "areas".

.2 Area (points and systems within an area).

.3 Area, system (points in system).

.4 System (points categorized by system type).

.5 System point (points categorized by system and point object type).

.6 Area point (points categorized by system and point object type).

.7 Point (points categorized by point object type).

.5 Summary report:

.1 Printout or display point object data value selected by operator.

.2 Report header to indicate status at time of request.

.3 Reports to be available on same basis as dynamic reports.

.4 Provide option for report type, point name, and output device.

.8 System Security:

.1 Password protection requirements:

.1 Operator access via username and password.

.2 Each user to be able to change their password through their user profile without requiring assistance from system administrator.

.3 User-definable and automatic log-off timers from 1 to 60 minutes, preventing operators from leaving devices on-line inadvertently.

.1 Default setting: 3 minutes.

.2 Use encrypted Hypertext Transfer Protocol Secure (HTTPS) to communicate between server and thin-client stations. Trusted certificates to be installed on devices communicating directly with the centralized BMS.

.1 Secure HTTP connectivity in accordance with Transport Layer Security (TLS) protocol, version 1.2.

.3 Centralized BMS to operate in compliance with BACnet Secure Connect (BACnet/SC).

.9 System Configuration:

.1 The Centralized BMS to include utility functions to manage the network of building automation controllers and other control devices installed on site.

.2 Software and tools utilized to generate, modify, and configure building controllers to be installed and operational at the Centralized BMS.

.3 Archiving and restoration module:

.1 Centralized BMS to include services to store backup copies of controller databases.

.1 Perform complete backup of software and data files at time of system installation.

.2 Provide backup copies before and after controller's revisions or major modifications.

.2 Provide continuous integrity supervision of controller databases. When controller encounters database integrity problems with its database, system to notify operator of need to download copy database to restore proper operation.

.3 Database backup and downloading to occur over local area network (LAN) without specialized operator technical knowledge. Provide operator with ability to manually download entire or partial controller database, as required.

.4 System diagnostics:

.1 System to include utility software to perform and view diagnostics of any control device connected to the integrated automation networks, with the capability to set devices "online" and "offline" for maintenance purposes.

.5 Control description logic (CDL) generator and modifier module.

.1 CDL generator module to permit generation and modification of CDLs in building automation controllers.

.2 Provide a complete library of standard programs, used for reference and fully customizable by the user to suit site-specific applications. Include programming components for various control applications in the library.

.3 Multiple program components can be selected and assembled to generate a specific operating sequence. Module to include cut, paste, search, and compare utilities for easy CDL modification and verification.

.4 Programming module allows the user to define input/output devices, monitoring programs and commands associated with system inputs/outputs.

.5 Provide a complete library set of control functions required to develop specific control logic and algorithms, including proportional-integral-derivative (PID) control loop algorithms, sequences, ratio functions, digitally-controlled analog outputs, analog-controlled digital outputs, logic inverter, scaling functions, Boolean operators, and arithmetic functions.

.6 Programming environment to be text-based (such as "basic") or graphic-based using function blocks.

.7 Module to permit testing of code before downloading to building controllers. User-selected inputs, outputs, and program variables (calculated data) can be displayed dynamically in real-time to verify program operation.

.8 Software allows addition of new building controllers and control objects without requiring manufacturer assistance.

## PART 3- EXECUTION

### 3.1 INSTALLATION

.1 Install Centralized BMS software on the hardware described in Section 25 24 00 – Integrated Automation System Architecture Requirements.

.1 Provide work necessary to interface the Centralized BMS with third-party systems, including the installation of software drivers/licenses, database entries, programming, and troubleshooting to obtain a fully functional system.

.2 System Configuration: Configure the Centralized BMS to standardize the following throughout the facility.

.1 Device setup: Naming conventions, device addressing, and user permissions.

.2 Object configuration: Point naming conventions, object tagging, and priority arrays.

.3 Minimum trending requirements.

.4 Local archiving configuration.

.5 Graphical user interface.

.3 Graphics Generation:

.1 Program dynamic graphics, including graphics required for integrated third-party systems.

.2 Configure graphics in collaboration with the Consultant.

### 3.2 CLOSEOUT ACTIVITIES

.1 System Configuration: Perform complete backup of software and data files at time of final acceptance.

**END OF SECTION**

## PART 1- GENERAL

### 1.1 SUMMARY

.1 Section Includes:

.1 Work requirements to interface the integrated automation system with work results specified in other Divisions.

.2 Requirements to perform cross-system data exchange, allowing the integrated automation system to read and/or modify control points residing in other building systems and enable integrated functionalities.

.3 Coordination work for cross-system integration to meet data communication requirements and integrated functionalities described in this section.

### 1.2 RELATED REQUIREMENTS

.1 Section 25 05 00 – Common Work Results for Integrated Automation
.2 Section 25 41 00 - Building Automation Controllers
.3 Section 25 90 00 – Integrated Automation Control Sequences

### 1.3 REFERENCE STANDARDS

.1 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):

.1 ANSI/ASHRAE 135-2020, BACnet – A Data Communication Protocol for Building Automation and Control Networks

### 1.4 ADMINISTRATIVE REQUIREMENTS

.1 Coordination:

.1 Coordinate integration work in this section with the requirements of Section 25 05 00 – Common Work Results for Integrated Automation.

.2 Coordinate with other trades to gather equipment and systems datasheets, manuals, and manufacturer instructions related to integration procedures, including device configuration, communication interfaces, list of available points, and read/write properties.

.1 Review submittals of equipment from other sections and recommend preferred communication interfaces before equipment is ordered.

.3 Coordinate integration support with equipment/system manufacturers as required.

.4 Coordinate and review network requirements for equipment/systems interfaced with integrated automation.

.5 Coordinate with work from other Divisions for compliance with project interoperability requirements.

.2 Coordinate the interface between Division 25 work and work of other Divisions.

### 1.5 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 – Closeout Submittals and Section 25 05 00 – Common Work Results for Integrated Automation.
.2 Building Systems Integration Manual:

.1 Submit manual documenting the building systems integration process and include list of integrated data points, testing results, and final configuration settings.

### 1.6 QUALITY ASSURANCE

.1 Qualifications:

.1 Work in this section to be performed by designated master systems integrator (MSI), as specified in Section 25 05 00 – Common Work Results for Integrated Automation.

## PART 2- PRODUCTS

### 2.1 SYSTEM INTERFACES

.1 Provide system interfaces through products supplied and installed under Division 25, such as building automation controllers and the centralized building management system (BMS).

.1 Provide transparent, efficient system interfaces that follow the recommended procedures described in manufacturers' literature and relevant data communication protocol standards.

.2 Provide additional hardware or software drivers required to setup and operate the system interface.

## PART 3-EXECUTION

### 3.1 GENERAL

.1 Verify building systems integration complies with the design philosophy described in Section 25 05 00 – Common Work Results for Integrated Automation.

.1 Each building system or equipment interfaced with the integrated automation system can function independently and perform their basic control functions.

.2 Cross-system integration and data exchange contribute to enhance the overall building performance and are used for:

.1 Data collection.

.2 Optimization of systems/equipment operation.

.3 Cross-system coordination of integrated functions.

.4 Establishing specific building management processes.

.2 Integrated Automation System: Serves as the central platform, facilitating interface between building systems and coordinating integrated functions. Use the centralized BMS to centralize the following functions:

.1 Alarming: Collect, archive, display, and manage alarms from multiple building systems.

.2 Scheduling: Create and manage centralized schedule and calendar functions to control multiple systems, concurrently, by zones or groups.

.3 Trending: Leverage the centralized BMS data historian and trending software to review and analyze datasets from multiple building systems concurrently.

.4 Operator interface: Display, control, manage, and supervise data points related to multiple building systems on a common human-machine interface (HMI).

### 3.2 CONFIGURATION AND PROGRAMMING

.1 Perform integration using one of the following types of system interface.

.1 Direct input/output (I/O): Hardwired connection to the I/O interface of a building automation controller, as described in Section 25 41 00 - Building Automation Controllers.

.2 Building automation system (BAS) communication: Data communication interface using a standard data communication protocol such as BACnet, in accordance with ANSI/ASHRAE 135. Interface may be setup at a supervisory type building automation controller (network management controller (NMC), system management controller (SMC)) or at the centralized BMS.

.3 Database Connection: Database interface using a standard database connector (such as structured query language (SQL), open database connectivity (ODBC), Java database connectivity (JDBC)) to the centralized BMS.

.2 Equipment may include a hardwired connection (for example, direct I/O interface) to provide direct control/supervision of equipment from building automation controllers in addition to a second interface to perform secondary data exchange.

.3 Prioritize the use of BACnet interoperability areas to control and manage third-party systems when using the BACnet data communication protocol to perform integration work. Interoperability areas include:

.1 Data sharing.

.2 Alarm and event management.

.3 Scheduling.

.4 Trending.

.5 Device and network management.

## 3.3 DATA INTEGRATION

.1 Integrate these systems and equipment to interface with the integrated automation system as specified.

.2 Data points listed under each system/equipment represent the minimum dataset to integrate with integrated automation for the purpose of achieving at least one of the following objectives:

.1 Monitor, display, and trend data at the centralized BMS.

.2 Program the sequences of operation described in Section 25 90 00 – Integrated Automation Control Sequences.

.3 Enable the integrated functions described in this section.

.3 Division 21 – Fire Protection:

.1 System or equipment name: Main fire alarm panel.

.1 System interface: Direct I/O.

.2 List of data points:

.1 General fire alarm.

.2 Trouble.

.4 Division 22 – Plumbing:

.1 System or equipment name: Domestic hot water heaters.

.1 System Interface: BAS communication using BACnet MSTP.

.2 List of data points:

.1 Domestic hot water (DHW) heater status.

.2 Fire rate – output.

.3 Active setpoint.

.4 DHW supply temperature.

.5 Alarms.

.6 DHW heater runtime.

.7 Status and fault (display code):

.1 Disabled.

.2 Standby.

.3 High water temperature limit.

.4 Low water level limit.

.2 System or equipment name: Natural gas meters.

.1 System interface: Direct I/O.

.2 List of data points:

.1 Gas consumption ($m^3$).

.3 System or equipment name: Water meters.

.1 System interface: Direct I/O.

.2 List of data points:

.1 Current flow (L/s).

.2 Total consumption ($m^3$).

.5 Division 23 – Heating, Ventilating and Air Conditioning (HVAC)

.1 Refer to I/O Tables.

## 3.4 INTEGRATED FUNCTIONS

.1 Master system integrator (MSI) to coordinate, configure, and program the integrated functions listed in this section.

.2 Coordinate and manage integrated functions from the integrated automation system. Use the centralized BMS and building automation controllers to implement the integrated functions listed in this section.

.3 Collect function drivers and critical datasets used in the integrated function's logic through a reliable process to trigger the automated feedback/control response.

.4 Apply automatic feedback/control requirements to the related systems/equipment listed in each function.

.5 Integrated Function Name: Occupancy detection.

.1 Description: Use of occupancy detector data from building systems to determine occupancy status in building zones and to analyze occupancy data and perform cross-system overrides.

.2 Function drivers:

.1 Occupancy sensors provided with HVAC equipment.

.2 Occupancy sensors provided under Division 25.

.3 Occupancy sensors provided with lighting controls.

.3 Automated feedback/control:

.1 Occupancy data is used to set the occupancy status in their assigned zone.

.2 Occupancy status overrides the zone schedule of related systems/equipment outside of normal hours.

.3 Occupancy data is logged for building data analytics purposes.

.4 Related systems/equipment:

.1 HVAC systems.

.2 Lighting controls.

.3 Plumbing equipment.

.6 Integrated Function Name: Synchronized scheduling.

.1 Description: Synchronization of building systems and equipment schedules by grouping systems and equipment serving common zones.

.2 Function drivers:

.1 Centralized BMS scheduling functions.

.3 Automated feedback/control:

.1 Provide a single-seat scheduling functionality at the centralized BMS by programming BACnet schedules for specific zones or logical groups.

.2 Provide the ability to modify the list of systems and equipment controlled under each scheduling group.

.3 Group schedules to coordinate the related systems based on normal schedule, occupancy status, master holiday events, and schedule overrides.

.4 Related systems/equipment:

.1 HVAC systems.

.2 Lighting controls.

.7 Integrated Function Name: Fire alarm condition.

.1 Description: Integrated Automation system to monitor the alarm status from the fire alarm system, log fire alarm events, and coordinate a response from other building systems.

.2 Function drivers:

.1 Main fire alarm status.

.2 Air handling unit (AHU) fire alarm interlocks.

.3 Automated feedback/control:

.1 Integrated Automation to monitor general fire alarm status and individual status from zones or systems (such as duct smoke detectors), when available.

.2 Individual systems and equipment to respond on fire alarm condition in accordance with sequences detailed in Section 25 90 00 – Integrated Automation Control Sequences.

.3 Fire alarm conditions to be annunciated at the centralized BMS and displayed on affected systems graphics. Operators to acknowledge and reset fire alarm conditions to restore system and equipment operation.

.4 Alarm flood suppression: Fire alarm conditions to disable nuisance alarms (for example, alarms generated as a result of the fire alarm condition override).

.4 Related systems/equipment:

.1 Fire alarm.

.2 HVAC systems.

.8 Integrated Function Name: Energy information database.

.1 Description: Collection and archiving of all energy-related data in a common database for overall building performance monitoring.

.2 Function drivers:

.1 Energy meters, including power meters, natural gas meters, water meters, thermal energy meters, and steam meters.

.2 Energy data provided by integrated equipment (such as VFDs, chillers) or systems (such as lighting controls).

.3 Energy data compiled and calculated at building automation controllers.

.3 Automated feedback/control:

.1 Centralized BMS to store all available energy-metering data within its database. Totalized energy consumption is sampled at minimum every 15 minutes.

.2 Centralized BMS to report energy use on hourly, daily, monthly, and annual bases.

.4 Related systems/equipment:

.1 HVAC systems and equipment.

.2 Energy meters.

.3 Lighting controls.

**END OF SECTION**

## PART 1- GENERAL

### 1.1 SUMMARY

.1 Section Includes:
- .1 Programming and configuration of site-specific requirements for sequences of operation to meet the Project's operational criteria.
- .2 Work results directly related to Division 25. Sequences of operation described in this section solely relate to physical and logical points under control and supervision of the integrated automation system.
  - .1 Third-party systems and packaged equipment with built-in controls are assumed to be provided with preprogrammed routines or configurable operating modes with which the integrated automation system interacts.

.2 Achieving a fully functional system compliant with the described sequences of operation extends beyond programming. It may include providing hardwire interlocks, adjusting instrument and control device settings, and modifying configuration parameters in third-party systems or equipment.

.3 Work specified in this section closely relates to equipment and work results specified in other sections of Division 25. Read this section in conjunction with:
- .1 The System Architecture Diagram provided on Drawings, showing requirements for systems and equipment to communicate and exchange data.
- .2 Controls schematics and input/output (I/O) schedules showing instrumentation and control devices deployed to perform direct control of equipment.
- .3 Instrumentation and control device requirements in other sections.

### 1.2 RELATED REQUIREMENTS

.1 Section 25 05 00 – Common Work Results for Integrated Automation
.2 Section 25 41 00 – Building Automation Controllers
.3 Section 25 70 00 – Integrated Automation Building Systems Integration

### 1.3 REFERENCE STANDARDS

.1 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
- .1 ASHRAE Guideline 36-2021, High Performance Sequences of Operation for HVAC Systems
- .2 ASHRAE/IES 90.1-2013, Energy Standard for Buildings Except Low-Rise Residential Buildings

### 1.4 ADMINISTRATIVE REQUIREMENTS

.1 Coordination:
- .1 Integrated Systems: Coordinate system interfaces connecting to integrated automation equipment with other Subcontractors, manufacturers, and suppliers to verify compliance with intended sequences of operation.
  - .1 Review submittals of third-party equipment and notify the Consultant when the proposed interface will affect the intended sequences of operation.
  - .2 Review third-party products and coordinate with trades to resolve integration issues and propose corrections.
- .2 Coordinate with Section 25 41 00 – Building Automation Controllers for software requirements.
- .3 Coordinate with Section 25 70 00 – Integrated Automation Building Systems Integration for integration and data flow requirements between the Division 25 environment and third-party systems.

### 1.5 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit sequences of operation during Shop Drawing review in accordance with Section 01 33 00 – Submittal Procedures and Section 25 05 00 – Common Work Results for Integrated Automation.

.2 Integrated Systems: Submit proposed changes to system interface and sequences of operation to the Consultant for review.

### 1.6 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 – Closeout Submittals and Section 25 05 00 – Common Work Results for Integrated Automation.

.2 Record Documentation:

.1 Submit recorded changes made to sequences of operation during construction and commissioning activities in accordance with Section 25 05 00 – Common Work Results for Integrated Automation.

.1 Submit a copy of sequences of operation in Microsoft Word format so changes can be made and saved by Owner's personnel. Protect files to prevent modifications by unauthorized users.

### 1.7 QUALITY ASSURANCE

.1 Qualifications:

.1 Programmers: Personnel specialized in configuring and commissioning this type of installation with five years of documented experience.

.2 Programmers to provide all control stratagems to ensure systems operate in a safe and efficient manner. Include delays, ramps, reset functions, interlocks, and cascade loops.

## PART 2 - PRODUCTS

### 2.1 NOT USED

.1 Not used.

## PART 3 - EXECUTION

### 3.1 PROGRAMMING CRITERIA

.2 Incorporate the following programming criteria when programming the sequences of operation:

.1 Setpoints, Schedules, and Calendars:

.1 Provide ability to adjust setpoints, schedules, and calendars without requiring program modifications.

.2 Operations and maintenance (O&M) staff with proper authorization levels can adjust setpoints, schedules, and calendars.

.3 Determine optimal setpoints, hours of operation, and calendar during commissioning phase, and complete adjustments.

.2 Operation Modes, Parameters, and Constants:

.1 Operator personnel with proper authorization level to have the ability to switch operating modes (such as occupied or unoccupied) and modify parameters, constants, and time delays without requiring programming modifications.

.3 Control Loops:

.1 Provide proportional and integral (PI) type control loops except as follows:

.1 Flow and pressure control loops: Proportional, integral, and derivative (PID) type.

.2 Limit control loops: Proportional type.

.2 Adjust control loops to provide stable operating system during extreme conditions.

.4 Starting Ramps:

.1 Incorporate control ramps during system start-up, or after a setpoint adjustment, to gradually bring control points to their setpoint values, preventing risks such as freezing, low pressure, and high pressure.

.2 Incorporate additional control ramps required for system operation or as requested by the Consultant during start-up.

.3 All control ramp rates to be adjustable.

.5 Alarms and Events:

.1 Alarm messages: Include timestamp, date, alarm level and description, equipment tags for involved components, and potential alarm trigger.

.2 Sensor failure: When a sensor failure is detected, the system is to disable the associated input point and transition dependent control points to a safe state.

.3 Alarm suppression: Interlock sensors located in ductwork or in hydronic system sensors with corresponding system statuses (such as fans, pumps, etc.) to suppress alarms when system is not operational.

.4 Analog alarms: Program two high-level alarms and two low-level alarms for each analog point. First alarm level to set operational limit and second alarm level to indicate measurement is out of range.

.5 Critical alarms: Program the following critical alarms when status is available.

.1 Equipment status does not match command (unauthorized on/off).

.2 Freeze risk.

.3 High and low pressure.

.4 Equipment fault status.

.5 Abnormal conditions (temperature, pressure, level).

.6 Maintenance alarms: Program the following alarms when status is available.

.1 Equipment alarm or trouble status.

.2 Equipment maintenance alarm.

.3 Dirty filters; coordinate setpoint values with Division 23.

.4 Equipment runtime limit.

.6 Motor Control:

.1 Equipment runtimes:

.1 Totalized and displayed on system graphical user interface.

.2 When runtime data is used for generating maintenance alarms or managing equipment rotation sequences, implement a separate logical point to reset the runtime to zero once it reaches a defined value.

.2 Rotation sequence selector for lead/lag and duty/standby operation:

.1 Program a selector switch on the graphical user interface to enable user to modify the rotation sequence and to manage equipment runtimes.

.7 Motor Interlocks:

.1 Abnormal "on" condition:

.1 Controller to enable control and execute sequence of operations of equipment if system is manually started (for example, motor starter in "hand" position).

.2 Abnormal "off" condition:

.1 When a controller detects a failed start or unexpected shutdown, system is turned off and locked out, after an adjustable delay, to prevent motor operation without a load (for example, broken drive belt) and to protect equipment.

.2 On lockout, the controller to immediately send a signal to control system loops to set field devices back to their shutdown state.

.3 Incorporate a manual reset button on the graphical user interface to restart the system and permit lockout function in or out of service.

.3 Programs and direct digital control (DDC) type controls to not override any safety interlocks.

.8 Starting After a Power Failure:

.1 Once power is restored, electro-mechanical equipment to restart in accordance with a predefined sequence to avoid power overload and control peak demand. Provide programmable start-up delay for each piece of equipment controlled.

.2 Systems equipped with low-power motors may be grouped under the control of a unique delay command. Total power (kW) to be the same and not exceed a maximum value for any group.

.9 Variable Frequency Drives (VFDs):

.1 For hydronic pumps controlled from VFDs, minimum speed of the pump to be ± 30% of rated full speed (revolutions per minute, RPM), or as directed by the manufacturer and balancing agent to meet minimum system safety, flow, and pressure requirements.

## 3.2 SEQUENCES OF OPERATION FOR RTU-1, RTU-2 AND RTU-3 – NORTH CLASSROOM ADDITION MULTIZONE DAIKIN BACNET ROOFTOP UNIT – CONSTANT VOLUME WITH GLYCOL HEATING, ENERGY RECOVERY AND HEAT PUMP

**Integration with Other Systems:**

Air Handling Unit will monitor heat and cool requests from associated zones as well as lowest, highest, and average zone temperatures.

**Run Conditions:**

Occupied - Scheduled:
The unit shall run when the time schedule is set to Occupied. During Occupied times the outside air dampers are enabled to provide a minimum percentage of outside air. See DCV sequence for details.

Standby - Scheduled:

The unit shall run when the time schedule is set to Standby. During Standby mode the minimum outside air % shall be 0%. DCV shall override the minimum outside air % if CO2 levels are above setpoint.

**Standby** – Triggered by Motion Sensor:
When in Unoccupied mode, the unit shall turn on in Standby Mode if the following conditions are true:

- Motion sensor control is true. This point is scheduled.
- AND the BAS has detected motion in a definable number of zones (initially set to 2).

During Standby mode the minimum outside air % shall be 0%. DCV shall override the minimum outside air % if CO2 levels are above setpoint.
The unit shall have minimum on/off times of 30 minutes.

Unoccupied Mode (System Off):
The supply and return/exhaust fans will be off. The return air dampers shall be positioned for full recirculation, exhaust air and fresh air dampers shall be fully closed.

Warmup Mode:
Warmup mode shall be activated if either of the following conditions are true:

- If a zone temperature drops below 16°C during unoccupied hours. Warmup shall stay active until the zone reaches 18 deg C.
- OR the optimal start algorithm is requesting heating.

During warmup mode, the mixed air dampers shall be positioned for full recirculation and the discharge air setpoint shall be 32 deg C.

Cooldown Mode:
Cooldown Mode shall be activated if the optimal start algorithm is requesting cooling. During cooldown mode, the mixed air dampers shall be positioned for full recirculation unless free cooling is available. The discharge air setpoint shall be 13 deg C.

Optimal Start:
The unit shall start prior to scheduled occupancy based on the time necessary for the zones to reach their occupied setpoints. The start time shall automatically adjust based on changes in outside air temperature and zone temperatures. Optimal Start shall be limited to the following times:

- Heating: 2 hours prior to Occupancy
- Cooling: 1 hour prior to Occupancy

**Unit Control:**

BAS sends occupancy signal and setpoints to the rooftop unit via BACnet communication. The rooftop unit controls supply and return/exhaust fans, heating, cooling, heat pump, economizer and heat recovery via factory controls. The BAS commands the following setpoints/parameters:

- Network Discharge Air Temperature Cooling Setpoint
- Network Discharge Air Temperature Heating Setpoint
- Space Temperature Input
- Building Static Pressure Setpoint
- Outdoor Air Minimum Position Input
- Occupancy Mode
- Occupied Heating Setpoint
- Unoccupied Heating Setpoint
- Occupied Cooling Setpoint
- Unoccupied Cooling Setpoint

Discharge Air Temperature Setpoint Calculation:

- The **heating** discharge air temperature setpoint shall be reset using the table below:

| Average Zone Temperature | Discharge Air Temperature Setpoint |
|---|---|
| 19°C | 25°C |
| 16°C | 32°C |

The **cooling** discharge air temperature setpoint shall be reset using the table below:

| Average Zone Temperature | Discharge Air Temperature Setpoint |
|---|---|
| 21°C | 20°C |
| 26°C | 13°C |

Additionally, the discharge air setpoint will be reset based on a weighted sum of heating and cooling requests.
Every zone heating request shall add 0.3°C to the discharge air setpoint and every zone cooling request shall deduct 0.3°C from the discharge air setpoint.
The discharge air setpoint shall be limited to a maximum of 32°C and a minimum of 13°C.

Cooling Setpoints:
The unit shall maintain the following temperatures:
- Average zone temperature of 23°C during occupied mode.
- Average zone temperature of 25°C during standby mode.
- Average zone temperature of 32°C during Unoccupied mode

Heating Setpoints:
The unit shall maintain the following temperatures:
- Average zone temperature of 20°C during occupied mode.
- Average zone temperature of 19°C during standby mode.
- Average zone temperature of 16°C during Unoccupied mode

Demand Control Ventilation – CO2 control:
During Occupied mode, the outside air dampers shall maintain the return CO2 setpoint by modulating between the Area Outdoor Air Rate and the Combined Outdoor Air Rate (Area Outdoor Rate + People Outdoor Air Rate) defined in Table 6.1 of ASHRAE 62-1 (both in L/s). The balancer shall determine the corresponding outdoor air damper positions for each flow rate.
- **OA Damper Minimum Position =** Area Outdoor Air Rate (%)
- **OA Damper Maximum CO2 Reset Limit =** Combined Outdoor Air Rate (%)

The return CO2 setpoint shall be **1000 ppm**.

BAS to calculate the effective minimum damper setpoint and send value to BACnet RTU controller by adjusting the **Outdoor Air Minimum Position Input.**

**Alarms:**

The BAS shall monitor the following unit alarms:
- Dirty Filter Alarm
- Duct Static Pressure High Limit

The BAS shall monitor the following alarms and translate the numerical value into the manufacturer state text table.
- Alarm Value
- Warning Alarm
- Problem Alarm

The BAS shall have the ability to clear the unit alarms by activating the following point:

- Clear Alarms

The BAS shall provide the following alarms:

- Low Discharge Air Temperature: If the discharge air temperature is less than 5°C for 5 minutes and the supply fan status is on.
- High Discharge Air Temperature: If the discharge air temperature is more than 49°C for 5 minutes and the supply fan status is on.
- Low Leaving Coil Temperature: If the leaving coil temperature is less than 5°C for 5 minutes and the supply fan status is on.
- High Return Air Carbon Dioxide Concentration: If the return air CO2 concentration is greater than 1100 ppm for 30 minutes and the supply fan status is on.
- Supply Fan Status: Mismatch between the unit command and the fan status for 30 minutes.
- Exhaust Fan Status: Mismatch between the unit command and the fan status for 30 minutes.

**Points:**

| BAS Points | | | | |
|---|---|---|---|---|
| Point Name | Trend | Alarm | Show on Graphic | Point Type |
| Effective Occupancy | x | | x | MV |
| Occupied Schedule | x | | x | MV |
| Occupancy Override | x | | x | MV |
| Warmup/Cooldown Command | x | | x | MV |
| Number of Heating Requests | x | | x | AV |
| Number of Cooling Requests | x | | x | AV |
| Highest Zone Temperature | x | | x | AV |
| Lowest Zone Temperature | x | | x | AV |
| Average Zone Temperature | x | | x | AV |
| Motion Sensor Status | x | | x | MV |
| Return Air CO2 | x | x | x | AI |
| OA Damper Minimum Position | | | x | AV |
| OA Damper Maximum CO2 Reset Limit | | | | AV |
| Occupied Cooling Setpoint | | | x | AV |
| Standby Cooling Setpoint | | | x | AV |
| Effective Cooling Setpoint | | | x | AV |
| Occupied Heating Setpoint | | | x | AV |
| Standby Heating Setpoint | | | x | AV |
| Effective Heating Setpoint | | | x | AV |
| BACnet Points – Daikin RTU | | | | |
| Point Name | Trend | Alarm | Show on Graphic | Point Type |
| Control Temperature | x | | x | Read |

| | | | | |
|---|---|---|---|---|
| Space Temperature Input<br>**Note: From AVGZN-T. Not shown on graphic.** | x | | | Write |
| Occupancy | x | | x | Read |
| Occupancy Mode<br>**Note: Used to schedule unit occupancy. Not shown on graphic** | x | | | Write |
| Discharge Air Temperature | x | x | x | Read |
| Effective Discharge Air Temperature Setpoint | x | | x | Read |
| Network Discharge Air Temperature Heating Setpoint | x | | x | Write |
| Network Discharge Air Temperature Cooling Setpoint | x | | x | Write |
| Occupied Heating Setpoint<br>**Note: From EFFHTG-SP. Not shown on graphic.** | x | | | Write |
| Unoccupied Heating Setpoint | x | | x | Write |
| Occupied Cooling Setpoint<br>**Note: From EFFCLG-SP. Not shown on graphic.** | x | | | Write |
| Unoccupied Cooling Setpoint | x | | x | Write |
| Leaving Coil Temperature | x | x | x | Read |
| Supply Fan Capacity | x | | x | Read |
| Exhaust/Return Fan Capacity | x | | x | Read |
| Building Static Pressure | x | | x | Read |
| Building Static Pressure Setpoint | x | | x | Write |
| Return Air Temperature | x | | x | Read |
| Return Air Enthalpy | x | | x | Read |
| Outdoor Air Temperature | x | | x | Read |
| Outdoor Air Enthalpy | x | | x | Read |
| Outdoor Air Damper Minimum Position Input<br>**Note: Not shown on graphic** | x | | | Write |
| Primary Heating Capacity – Heat Pump | x | | x | Read |
| Supplemental Heating Capacity – Glycol Heating | x | | x | Read |
| Cooling Capacity | x | | x | Read |
| Economizer Capacity | x | | x | Read |
| Economizer Status | x | | x | Read |
| Primary Heating Status – Heat Pump | x | | x | Read |
| Secondary Heating Status – Glycol Heating | x | | x | Read |
| Cooling Status | x | | x | Read |
| Airflow Switch | x | | x | Read |
| Energy Recovery Entering Wheel Temperature | x | | x | Read |

| | | | | |
|---|---|---|---|---|
| Energy Recovery Leaving Wheel Temperature | x | | x | Read |
| Energy Recovery Wheel Capacity | x | | x | Read |
| Energy Recovery Wheel Status | x | | x | Read |
| Unit State | x | | x | Read |
| Alarm Value | x | x | x | Read |
| Warning Alarm | x | x | x | Read |
| Active Alarm | x | x | x | Read |
| Dirty Filter Alarm | x | x | x | Read |
| Clear Alarms | x | | x | Write |
| High Duct Static Pressure Alarm | x | x | x | Read |

### 3.3 SEQUENCES OF OPERATION FOR RTU-4, RTU-5 – LEARNING COMMONS - TRANE ROOFTOP UNIT – CONSTANT VOLUME WITH DX COOLING AND GAS HEATING

**Run Conditions – Scheduled:**
The unit shall run according to a user definable time schedule in the following modes:

- Occupied Mode: The unit shall maintain
  - 23°C cooling setpoint
  - 21°C heating setpoint.

- Standby Mode: The unit shall maintain
  - 25°C cooling setpoint
  - 19°C heating setpoint.

- Unoccupied Mode (night setback): The unit shall maintain
  - 32°C cooling setpoint.
  - 16°C heating setpoint.

Occupied - Scheduled:
The unit shall run when the time schedule is set to Occupied. During Occupied times the outside air dampers are enabled to provide a minimum percentage of outside air. See DCV sequence for details.

Standby - Scheduled:
The unit shall run when the time schedule is set to Standby. During Standby mode the minimum outside air % shall be 0%. DCV shall override the minimum outside air % if CO2 levels are above setpoint.

**Standby** – Triggered by Motion Sensor:
When in Unoccupied mode, the unit shall turn on in Standby Mode if the following conditions are true:
- Motion sensor control is true. This point is scheduled.
- AND the BAS has detected motion for a definable number of minutes (initially set to 2 minutes)

During Standby mode the minimum outside air % shall be 0%. DCV shall override the minimum outside air % if CO2 levels are above setpoint.
The unit shall have minimum on/off times of 30 minutes.

Unoccupied Heating/Cooling:
The unit shall cycle to maintain the Unoccupied heating and cooling setpoints. During Unoccupied hours the outside air damper shall be disabled.

Zone Optimal Start:
The unit shall use an optimal start algorithm for morning start-up. This algorithm shall minimize the unoccupied warm-up or cool-down period while still achieving comfort conditions by the start of scheduled occupied period. Optimal Start shall be limited to the following times:

- Heating: 2 hours prior to Occupancy
- Cooling: 1 hour prior to Occupancy

The outside air damper shall be disabled during optimal start.

**Unit Control:**

BAS sends occupancy signal and setpoints to the rooftop unit via BACnet communication. The rooftop unit controls supply and return/exhaust fans, heating, cooling and economizer via factory controls. The BAS commands the following setpoints/parameters:

- Unoccupied Heating Setpoint
- Unoccupied Cooling Setpoint
- Outdoor Air Minimum Position Setpoint
- Occupancy Request
- Economizer Minimum Position Command
- Cooling Lockout Command
- Heating Lockout Command
- Space Temperature Setpoint BAS
- Occupied Offset
- Standby Offset

Demand Control Ventilation – CO2 control:
During Occupied mode, the outside air dampers shall maintain the return/space CO2 setpoint by modulating between the Area Outdoor Air Rate and the Combined Outdoor Air Rate (Area Outdoor Rate + People Outdoor Air Rate) defined in Table 6.1 of ASHRAE 62-1 (both in L/s). The balancer shall determine the corresponding outdoor air damper positions for each flow rate.

- **OA Damper Minimum Position =** Area Outdoor Air Rate (%)
- **OA Damper Maximum CO2 Reset Limit =** Combined Outdoor Air Rate (%)

The return/space CO2 setpoint shall be **1000 ppm**.
**BAS to calculate the effective minimum damper setpoint and send value to BACnet RTU controller.**

Mechanical Cooling Disable:
The BAS shall disable mechanical cooling when the outside air temperature is less than 18°C.

Heating Disable:
The BAS shall disable heating when the outside air temperature is above 15°C.

Economizer Disable:
The BAS shall disable the economizer for cooling when the outside air temperature is above 19°C.

**Diagnostics:**
The BAS shall monitor all RTU diagnostics. There shall be a separate link in the graphic which shows a table view of all current diagnostics.

**Alarms:**

The BAS shall monitor the following unit alarms:

- Supply Fan Failure Alarm

- Compressor Lockout Status
- Heating Failure Alarm
- Dirty Filter Alarm
- High Duct Static Pressure Alarm

The BAS shall provide the following alarms:

- Low Discharge Air Temperature: If the discharge air temperature is less than 5°C for 5 minutes and the supply fan status is on.
- High Discharge Air Temperature: If the discharge air temperature is more than 49°C for 5 minutes and the supply fan status is on.
- Low Mixed Air Temperature: If the mixed air temperature is less than 5°C for 5 minutes and the supply fan status is on.
- High Return Air Carbon Dioxide Concentration: If the return air CO2 concentration is greater than 1100 ppm for 30 minutes and the supply fan status is on.
- Low Zone Temperature – Zone shall generate an alarm when its temperature drops below 10°C for 30 minutes.
- Supply Fan Status: Mismatch between the unit command and the fan status for 30 minutes.
- Exhaust Fan Status: Mismatch between the unit command and the fan status for 30 minutes.

**Points:**

| BAS Points | | | | |
|---|---|---|---|---|
| Point Name | Trend | Alarm | Show on Graphic | Point Type |
| Effective Occupancy | x | | x | MV |
| Occupied Schedule | x | | x | MV |
| Occupancy Override | x | | x | MV |
| Warmup/Cooldown Command | x | | x | MV |
| Motion Sensor | x | | x | BI |
| Zone CO2 | x | x | x | AI |
| Zone Temperature | x | x | x | AI |
| OA Damper Minimum Position | | | x | AV |
| OA Damper Maximum CO2 Reset Limit | | | | AV |
| Economizer Switchover Setpoint | | | x | AV |
| Cooling OA-T Lockout Setpoint | | | x | AV |
| Heating OA-T Lockout Setpoint | | | x | AV |
| Discharge Air Temperature | x | x | x | AI |
| Return Air Temperature | x | | x | AI |
| BACnet Points – Trane RTU | | | | |
| Point Name | Trend | Alarm | Show on Graphic | Point Type |
| Compressor Lockout Status | x | x | x | Read |
| Cooling Lockout Command | x | | x | Write |
| Cooling Stage 1 Output Status | x | | x | Read |

| | | | | |
|---|---|---|---|---|
| Cooling Stage 2 Output Status | x | | x | Read |
| Dirty Filter Alarm | x | x | x | Read |
| Economizer Minimum Position Command | x | | x | Write |
| Economizer Minimum Position Setpoint BAS | x | | x | Write |
| Economizer System Status | x | | x | Read |
| Exhaust Enable Damper Position Setpoint Status | x | | | Read |
| Exhaust Fan Command Status | x | | x | Read |
| Exhaust Fan Proving Status | x | x | x | Read |
| Exhaust Fan Speed Command | x | | x | Read |
| Fan Failure Alarm | x | x | x | Read |
| Heat Lockout Command | x | | x | Write |
| Heat/Cool Mode Status | x | | x | Read |
| Heating Failure | x | x | x | Read |
| Heating Stage 1 Output Status | x | | x | Read |
| Heating Stage 2 Output Status | x | | x | Read |
| Mixed Air Temperature | x | x | x | Read |
| Occupancy Request | x | | | Write |
| Occupancy Status | x | | x | Read |
| Occupied Offset | x | | x | Write |
| Outdoor Air Damper Position Status | x | | x | Read |
| Outdoor Air Temperature Active | x | | x | Read |
| Power Exhaust Enable Setpoint BAS | | | | Write |
| Space Temperature Active | x | | | Read |
| Space Temperature BAS | x | | | Write |
| Space Temperature Setpoint Active | x | | x | Read |
| Space Temperature Setpoint BAS | x | | x | Write |
| Standby Offset | x | | x | Write |
| Supply Air High Pressure Alarm | x | x | x | Read |
| Supply Fan Command Status | x | | x | Read |
| Supply Fan Maximum Speed BAS | | | | Write |
| Supply Fan Minimum Speed BAS | | | | Write |
| Supply Fan Proving Status | x | x | x | Read |
| Supply Fan Speed Command | x | | x | Read |
| System Control Command | x | | x | Read |
| System Control Status | x | | x | Read |
| Unoccupied Cooling Setpoint | | | x | Write |
| Unoccupied Heating Setpoint | | | x | Write |

### 3.4 SEQUENCES OF OPERATION FOR RTU-6 – WEST CAFETERIA - Trane Rooftop Unit – CONSTANT VOLUME WITH DX COOLING AND GLYCOL HEATING

**Run Conditions – Scheduled:**
The unit shall run according to a user definable time schedule in the following modes:

- Occupied Mode: The unit shall maintain
  - 23°C cooling setpoint
  - 21°C heating setpoint.

- Standby Mode: The unit shall maintain
  - 25°C cooling setpoint
  - 19°C heating setpoint.

- Unoccupied Mode (night setback): The unit shall maintain
  - 32°C cooling setpoint.
  - 16°C heating setpoint.

Occupied – Scheduled:
The unit shall run when the time schedule is set to Occupied. During Occupied mode the outside air damper shall be enabled.

Standby - Scheduled:
The unit shall run when the time schedule is set to Standby. During Standby mode the outside air damper shall be disabled.

**Occupied** – Triggered by Motion Sensor:
When in Unoccupied mode, the unit shall turn on in Occupied Mode if the following conditions are true:
- Motion sensor control is true. This point is scheduled.
- AND the BAS has detected motion for a definable number of minutes (initially set to 2 minutes)

The unit shall have minimum on/off times of 30 minutes.

Unoccupied Heating/Cooling:
The unit shall cycle to maintain the Unoccupied heating and cooling setpoints. During Unoccupied hours the outside air damper shall be disabled.

Zone Optimal Start:
The unit shall use an optimal start algorithm for morning start-up. This algorithm shall minimize the unoccupied warm-up or cool-down period while still achieving comfort conditions by the start of scheduled occupied period. Optimal Start shall be limited to the following times:
- Heating: 2 hours prior to Occupancy
- Cooling: 1 hour prior to Occupancy

The outside air damper shall be disabled during optimal start.

Supply Fan:
The supply fan shall run anytime the unit is commanded to run. To prevent short cycling, the supply fan shall have a minimum runtime of 30 minutes.

Freeze Protection:
The unit shall shut down and generate an alarm upon receiving a freezestat status.

Glycol Reheat 1 Discharge Air Temperature Monitoring:

The controller shall monitor the discharge air temperature.

Glycol Reheat 1 Low Temperature Alarm Monitoring:
BAS to monitor status of low temperature alarm downstream of both glycol heating coils.

Glycol Reheat 2 Discharge Air Temperature Monitoring:
The controller shall monitor the discharge air temperature.

Glycol Reheat 2 Low Temperature Alarm Monitoring:
BAS to monitor status of low temperature alarm downstream of both glycol heating coils.

Return Air Temperature Monitoring:
The controller shall monitor the return air temperature.

Mixed Air Temperature Monitoring:
The controller shall monitor the mixed air temperature.

Glycol Reheat Valve Control:
The glycol valve shall modulate to maintain the effective zone heating setpoint.
Heating shall be enabled whenever:

- The outdoor air temperature is less than 15°C.
- AND the supply fan status is on.

Economizer:
The outside air dampers shall be controlled by the rooftop unit's onboard controls for free cooling. The outside damper shall only be enabled if the effective occupancy is occupied.

Mechanical Cooling Control:
The cooling stages shall be controlled to maintain the effective zone cooling setpoint. There shall be a user definable delay between stages, and each stage shall have a user definable minimum runtime.
Cooling shall be enabled whenever:

- The outside air temperature is greater than 13°C.
- AND the supply fan status is on.
- AND the heating (if present) is not active.

Filter Monitoring:
The differential pressure across the filters shall be monitored. An alarm shall be generated if the differential pressure is greater than 250 Pa for 5 minutes.

**Alarms:**

- Low Zone Temperature: Zone shall generate an alarm when its temperature drops below 10°C for 30 minutes.
- Supply Fan Status: Mismatch between the fan command and the fan status for 30 minutes.
- Low Discharge Air Temperature: If the discharge air temperature is less than 5°C for 5 minutes and the supply fan status is on.
- High Discharge Air Temperature: If the discharge air temperature is more than 49°C for 5 minutes and the supply fan status is on.
- Low Zone Temperature – Zone shall generate an alarm when its temperature drops below 10°C for 30 minutes.
- Low Mixed Air Temperature: If the mixed air temperature is less than 5°C for 5 minutes and the supply fan status is on.
- Dirty Filter Alarm: Differential pressure is greater than 250 Pa for 5 minutes.

**Points:**

| BAS Points | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Point Name | Hardware Points | | | | Software Points | | | Trend | Alarm | Show on Graphic |
| | AI | AO | BI | BO | AV | BV | MV | | | |
| Zone Temperature | x | | | | | | | x | x | x |
| Discharge Air Temperature 1 | x | | | | | | | x | x | x |
| Discharge Air Temperature 2 | x | | | | | | | x | x | x |
| Low Temperature Alarm 1 | | | x | | | | | x | x | x |
| Low Temperature Alarm 2 | | | x | | | | | x | x | x |
| Supply Fan Command | | | | x | | | | x | | x |
| Supply Fan Amps | x | | | | | | | x | | x |
| Supply Fan Status | | | | | | | x | x | x | x |
| Supply Fan Alarm | | | x | | | | | x | x | x |
| Exhaust Fan Amps | x | | | | | | | x | | x |
| Exhaust Fan Status | | | | | | | x | x | x | x |
| Motion Sensor Status | | | x | | | | | x | | x |
| Effective Occupancy | | | | | | | x | x | | x |
| Occupied Schedule | | | | | | | x | x | | x |
| Occupancy Override | | | | | | | x | | | x |
| Outdoor Damper Enable | | | | x | | | | x | | x |
| Return Air Temperature | x | | | | | | | x | | x |
| Mixed Air Temperature | x | | | | | | | x | | x |
| Effective Heating Setpoint | | | | | x | | | x | | x |
| Effective Cooling Setpoint | | | | | x | | | x | | x |
| Occupied Heating Setpoint | | | | | x | | | | | x |
| Occupied Cooling Setpoint | | | | | x | | | | | x |
| Standby Heating Setpoint | | | | | x | | | | | x |
| Standby Cooling Setpoint | | | | | x | | | | | x |
| Unoccupied Heating Setpoint | | | | | x | | | | | x |
| Unoccupied Cooling Setpoint | | | | | x | | | | | x |
| Reheat Valve 1 Output | | x | | | | | | x | | x |
| Reheat Valve 2 Output | | x | | | | | | x | | x |
| Cooling Stage 1 Command | | | | x | | | | x | | x |
| Cooling Stage 2 Command | | | | x | | | | x | | x |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Outdoor Air Temperature | | | | | x | | | x | | x |
| Warmup/Cooldown Command | | | | | | | x | x | | x |
| AHU State | | | | | | | x | x | | x |
| Filter Differential Pressure | x | | | | | | | x | x | x |
| Cooling OA-T Lockout Setpoint | | | | | x | | | | | x |
| Heating OA-T Lockout Setpoint | | | | | x | | | | | x |

### 3.5 SEQUENCES OF OPERATION FOR RTU-7 WOOD AND WELDING SHOP CONSTANT VOLUME WITH GAS HEATING – 100% OUTDOOR AIR

**Run Conditions:**
The unit shall run when the dust collector status is on.

The unit shall maintain:
- 20°C zone temperature heating setpoint.

**Unit Control:**

BAS sends occupancy signal and setpoints to the rooftop unit via BACnet communication. The rooftop unit controls supply fan and heating via factory controls. The BAS commands the following setpoints/parameters:
- Occupied Heating Setpoint
- Network Discharge Air Temperature Heating Setpoint
- Occupancy Mode

Discharge Air Temperature Reset Control:
The **heating** discharge air temperature setpoint shall be reset using the table below:

| Zone Temperature | Discharge Air Temperature Setpoint |
|---|---|
| 20°C | 25°C |
| 16°C | 32°C |

When the zone temperature is above the zone heating setpoint the discharge air temperature setpoint shall be 18 deg C.

Outdoor Air Damper Control:
If the dust collector status is on and the unit is running, the outside air dampers shall be 100% open.

**Alarms:**

The BAS shall monitor the following unit alarms:
- Dirty Filter Alarm
- Duct Static Pressure High Limit

The BAS shall monitor the following alarms and translate the numerical value into the manufacturer state text table.
- Alarm Value
- Warning Alarm
- Problem Alarm

The BAS shall have the ability to clear the unit alarms by activating the following point:

- Clear Alarms

The BAS shall provide the following alarms:

- Low Discharge Air Temperature: If the discharge air temperature is less than 5°C for 5 minutes and the supply fan status is on.
- High Discharge Air Temperature: If the discharge air temperature is more than 49°C for 5 minutes and the supply fan status is on.
- Supply Fan Status: Mismatch between the unit command and the fan status for 30 minutes.
- Low Zone Temperature – Zone shall generate an alarm when its temperature drops below 10°C for 30 minutes.

**Points:**

| BAS Points | | | | |
|---|---|---|---|---|
| Point Name | Trend | Alarm | Show on Graphic | Point Type |
| Zone Temperature | x | x | x | AI |
| Dust Collector Status | x | | x | BI |
| Unit Command | x | | x | MV |
| BACnet Points -Daikin RTU | | | | |
| Point Name | Trend | Alarm | Show on Graphic | Point Type |
| Control Temperature | x | | x | Read |
| Space Temperature Input<br>**Note: From ZN-T. Not shown on graphic** | x | | | Write |
| Occupancy | x | | x | Read |
| Occupancy Mode<br>**Note: Used to schedule unit occupancy. Not shown on graphic** | x | | | Write |
| Discharge Air Temperature | x | x | x | Read |
| Effective Discharge Air Temperature Setpoint | x | | x | Read |
| Network Discharge Air Temperature Heating Setpoint | x | | x | Write |
| Leaving Coil Temperature | x | | x | Read |
| Occupied Heating Setpoint | x | | x | Write |
| Supply Fan Capacity | x | | x | Read |
| Outdoor Air Temperature | x | | x | Read |
| Outdoor Air Enthalpy | x | | x | Read |
| Economizer Capacity | x | | x | Read |
| Heating Capacity – Gas Heating | x | | x | Read |
| Heating Status- Gas Heating | x | | x | Read |
| Airflow Switch | x | | x | Read |
| Outdoor Air Temperature | x | | x | Read |
| Unit State | x | | x | Read |

| | | | | |
|---|---|---|---|---|
| Alarm Value | x | x | x | Read |
| Warning Alarm | x | x | x | Read |
| Active Alarm | x | x | x | Read |
| Dirty Filter Alarm | x | x | x | Read |
| Clear Alarms | x | | x | Write |
| High Duct Static Pressure Alarm | x | x | x | Read |

### 3.6 SEQUENCES OF OPERATION FOR RTU-8 – AUTO SHOP CONSTANT VOLUME WITH GAS HEATING

Run Conditions:
The unit shall run when the following conditions are true:

- The schedule is Occupied.

The unit shall maintain:

- 20°C occupied heating setpoint.
- 22°C occupied cooling setpoint.

**Unit Control:**

BAS sends occupancy signal and setpoints to the rooftop unit via BACnet communication. The rooftop unit controls supply and return/exhaust fans, heating, and economizer via factory controls. The BAS commands the following setpoints/parameters:

- Network Discharge Air Temperature Cooling Setpoint
- Network Discharge Air Temperature Heating Setpoint
- Space Temperature Input
- Building Static Pressure Setpoint
- Outdoor Air Minimum Position Input
- Occupancy Mode
- Occupied Heating Setpoint
- Occupied Cooling Setpoint

Discharge Air Temperature Reset Control
The **heating** discharge air temperature setpoint shall be reset using the table below:

| Zone Temperature | Discharge Air Temperature Setpoint |
|---|---|
| 20°C | 25°C |
| 16°C | 32°C |

The **cooling** discharge air temperature setpoint shall be reset using the table below:

| Zone Temperature | Discharge Air Temperature Setpoint |
|---|---|
| 22°C | 18°C |
| 26°C | 13°C |

Outdoor Air Damper Control:
During Occupied mode, the outside air dampers shall maintain the minimum outside air setpoint.
If the tailpipe exhaust fan status is on, the outside air dampers shall be 100% open.

BAS to send value to BACnet RTU controller by adjusting the **Outdoor Air Minimum Position Input.**

**Alarms:**

The BAS shall monitor the following unit alarms:

- Dirty Filter Alarm
- Duct Static Pressure High Limit

The BAS shall monitor the following alarms and translate the numerical value into the manufacturer state text table.

- Alarm Value
- Warning Alarm
- Problem Alarm

The BAS shall have the ability to clear the unit alarms by activating the following point:

- Clear Alarms

The BAS shall provide the following alarms:

- Low Discharge Air Temperature: If the discharge air temperature is less than 5°C for 5 minutes and the supply fan status is on.
- High Discharge Air Temperature: If the discharge air temperature is more than 49°C for 5 minutes and the supply fan status is on.
- Supply Fan Status: Mismatch between the unit command and the fan status for 30 minutes.
- Low Zone Temperature – Zone shall generate an alarm when its temperature drops below 10°C for 30 minutes.

**Points:**

| BAS Points | | | | |
|---|---|---|---|---|
| Point Name | Trend | Alarm | Show on Graphic | Point Type |
| Effective Occupancy | x | | x | MV |
| Occupied Schedule | x | | x | MV |
| Occupancy Override | x | | x | MV |
| Zone Temperature | x | x | x | AI |
| OA Damper Minimum Position | | | x | AV |
| Tailpipe Exhaust Fan Status | x | | x | BI |
| BACnet Points -Daikin RTU | | | | |
| Point Name | Trend | Alarm | Show on Graphic | Point Type |
| Control Temperature | x | | x | Read |
| Space Temperature Input<br>**Note: From ZN-T. Not Shown on graphic** | x | | | Write |
| Occupancy | x | | x | Read |
| Occupancy Mode<br>**Note: Used to schedule unit occupancy. Not shown on graphic** | x | | | Write |

| | | | | |
|---|---|---|---|---|
| Discharge Air Temperature | x | x | x | Read |
| Effective Discharge Air Temperature Setpoint | x | | x | Read |
| Network Discharge Air Temperature Heating Setpoint | x | | x | Write |
| Network Discharge Air Temperature Cooling Setpoint | x | | x | Write |
| Leaving Coil Temperature | x | | x | Read |
| Occupied Heating Setpoint | x | | x | Write |
| Supply Fan Capacity | x | | x | Read |
| Exhaust Fan Capacity | x | | x | Read |
| Return Air Temperature | x | | x | Read |
| Return Air Enthalpy | x | | x | Read |
| Outdoor Air Temperature | x | | x | Read |
| Outdoor Air Enthalpy | x | | x | Read |
| Outdoor Air Damper Minimum Position Input **Note: Not shown on graphic** | x | | | Write |
| Primary Heating Capacity - Gas Heating | x | | x | Read |
| Economizer Capacity | x | | x | Read |
| Economizer Status | x | | x | Read |
| Heating Status – Gas Heating | x | | x | Read |
| Airflow Switch | x | | x | Read |
| Outdoor Air Temperature | x | | x | Read |
| Unit State | x | | x | Read |
| Alarm Value | x | x | x | Read |
| Warning Alarm | x | x | x | Read |
| Active Alarm | x | x | x | Read |
| Dirty Filter Alarm | x | x | x | Read |
| Clear Alarms | x | | x | Write |
| High Duct Static Pressure Alarm | x | x | x | Read |

### 3.7 SEQUENCES OF OPERATION FOR AHU-1 – CENTRAL CLASSROOMS MULTIZONE AIR HANDLING UNIT – CONSTANT VOLUME WITH DX COOLING, GLYCOL HEATING AND ENERGY RECOVERY

**Integration with Other Systems:**

Air Handling Unit will monitor heat and cool requests from associated zones as well as lowest, highest, and average zone temperatures. It will work in conjunction with its associated ERV to provide air flow.

**Run Conditions:**

Occupied - Scheduled:
The unit shall run when the time schedule is set to Occupied. During Occupied times the outside air dampers are enabled to provide a minimum percentage of outside air. See DCV sequence for details.

Standby - Scheduled:
The unit shall run when the time schedule is set to Standby. During Standby mode the minimum outside air % shall be 0%. DCV shall override the minimum outside air % if CO2 levels are above setpoint.

**Standby** – Triggered by Motion Sensor:
When in Unoccupied mode, the unit shall turn on in Standby Mode if the following conditions are true:

- Motion sensor control is true. This point is scheduled.
- AND the BAS has detected motion in a definable number of zones (initially set to 2).

During Standby mode the minimum outside air % shall be 0%. DCV shall override the minimum outside air % if CO2 levels are above setpoint.
The unit shall have minimum on/off times of 30 minutes.

Unoccupied Mode (System Off):
The supply and return/exhaust fans will be off. The AHU's return air dampers shall be positioned for full recirculation, exhaust air and fresh air dampers shall be fully closed. The ERV's exhaust and return air dampers shall also be fully closed.

Warmup Mode:
Warmup mode shall be activated if either of the following conditions are true:

- If a zone temperature drops below 16°C during unoccupied hours. Warmup shall stay active until the zone reaches 18 deg C.
- OR the optimal start algorithm is requesting heating.

During warmup mode, the mixed air dampers shall be positioned for full recirculation and the discharge air setpoint shall be 32 deg C.

Cooldown Mode:
Cooldown Mode shall be activated if the optimal start algorithm is requesting cooling. During cooldown mode, the mixed air dampers shall be positioned for full recirculation unless free cooling is available. The discharge air setpoint shall be 13 deg C.

Optimal Start:
The unit shall start prior to scheduled occupancy based on the time necessary for the zones to reach their occupied setpoints. The start time shall automatically adjust based on changes in outside air temperature and zone temperatures. Optimal Start shall be limited to the following times:

- Heating: 2 hours prior to Occupancy
- Cooling: 1 hour prior to Occupancy

Freeze Protection:
The unit shall shut down and generate an alarm upon receiving a freezestat status.

Return Fan:
The return fan shall run anytime the unit is commanded to run, unless shutdown on safeties. To prevent short cycling, the return fan shall have a minimum runtime of 30 minutes. The return fan shall run at a fixed % (determined by balancer).

Supply Fan:

The supply fan shall start 10 seconds after receiving return fan status. The supply fan shall run at a fixed % (determined by balancer).

Discharge Air Temperature Setpoint Calculation:
The discharge air temperature setpoint shall be reset using the table below:

| Average Zone Temperature | Discharge Air Temperature Setpoint |
|---|---|
| 20°C | 25°C |
| 24°C | 13°C |

Additionally, the discharge air setpoint will be reset based on a weighted sum of heating and cooling requests. Every zone heating request shall add 0.2°C to the discharge air setpoint and every zone cooling request shall deduct 0.2°C from the discharge air setpoint.
The discharge air setpoint shall be limited to a maximum of 32°C and a minimum of 13°C.

Glycol Heating Valve Control:
The heating valve shall modulate to maintain the discharge air temperature setpoint. The heating valve and mixed air dampers shall modulate sequentially, without overlapping.
Heating shall be enabled whenever:

- The discharge air temperature is below the heating setpoint.
- AND the outdoor air temperature (OAT) is less than 15°C.

When the system is off, the heating coil valve shall modulate to maintain a plenum temperature of 13°C.
The heating coil valve shall open 100% whenever the freezestat is in alarm.

Demand Control Ventilation (DCV) – CO2 control:
During Occupied mode, the outside air dampers shall maintain the return/space CO2 setpoint by modulating between the Area Outdoor Air Rate and the Combined Outdoor Air Rate (Area Outdoor Rate + People Outdoor Air Rate) defined in Table 6.1 of ASHRAE 62-1 (both in L/s). The balancer shall determine the corresponding outdoor air damper positions for each flow rate.

- **OA Damper Minimum Position =** Area Outdoor Air Rate (%)
- **OA Damper Maximum CO2 Reset Limit =** Combined Outdoor Air Rate (%)

The return/space CO2 setpoint shall be **1000 ppm**.

Economizer and ERV Operation:
Heating Mode

- The economizer dampers shall remain closed and ERV shall be commanded on.
- ERV SF and EF shall modulate as required to maintain DCV as noted.

Cooling

- If Outdoor Air Temperature < Return Air Temperature, the economizer dampers shall modulate between minimum and maximum position to maintain DCV as noted
- If Outdoor Air Temperature > Return Air Temperature, the ERV shall be commanded on, and modulate ERV SF and RF shall modulate as required to maintain DCV as noted.

Economizer:
The economizer dampers shall modulate to prevent the mixed air temperature from dropping below 10°C.

ERV:
The ERV dampers shall open upon BAS command to ERV.
Mechanical Cooling Control:
The controller shall stage the condenser to maintain

- 23°C average zone temperature during occupied mode
- 25°C average zone temperature during standby mode.

Issued for Addendum #3

- 32°C average zone temperature during unoccupied mode.

The controller shall limit the discharge air temperature from dropping below 8 deg C while cooling is active. There shall be minimum on/off times of 5 minutes for each stage unless an alarm occurs.
Mechanical cooling shall be enabled whenever:

- The outside air temperature is greater than 18°C
- AND economizer is not available or is fully open.
- AND heating (if present) is not active.

Supply and Return Fan VFD Monitoring:
The supply and return fan VFDs shall have a hardwired start/stop signal from the BAS.
The BAS shall monitor the supply and return fan status via current sensors that are hardwired back to the BAS controller.

The following VFD points shall be monitored:

- Supply Fan VFD Alarm
- Return Fan VFD Alarm
- Supply Fan Kilowatts
- Return Fan Kilowatts

Filter Monitoring:
The differential pressure across the filters shall be monitored. An alarm shall be generated if the differential pressure is greater than 250 Pa for 5 minutes.

**Alarms:**

- Return Fan Status: Mismatch between the fan command and the fan status for 30 minutes.
- Supply Fan Status: Mismatch between the fan command and the fan status for 30 minutes.
- Low Discharge Air Temperature: If the discharge air temperature is less than 5°C for 5 minutes and the supply fan status is on.
- High Discharge Air Temperature: If the discharge air temperature is more than 49°C for 5 minutes and the supply fan status is on.
- Low Mixed Air Temperature: If the mixed air temperature is less than 5°C for 5 minutes and the supply fan status is on.
- Dirty Filter Alarm: Differential pressure is greater than 250 Pa for 5 minutes.
- High Return Air Carbon Dioxide Concentration: If the return air CO2 concentration is greater than 1100 ppm for 30 minutes and the supply fan status is on.
- Supply Fan VFD Alarm
- Return Fan VFD Alarm
- Temperature Low Limit Alarm

**Points:**

| BAS Points | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Point Name | Hardware Points | | | | Software Points | | | Trend | Alarm | Show on Graphic |
| | AI | AO | BI | BO | AV | BV | MV | | | |
| Discharge Air Temperature | x | | | | | | | x | x | x |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Discharge Air Temperature Setpoint | | | | | x | | | x | | x |
| Supply Fan Command | | | | x | | | | x | | x |
| Supply Fan Output (Fixed %) | | x | | | | | | x | | x |
| Supply Fan Amps | x | | | | | | | x | | x |
| Supply Fan Status | | | | | | | x | x | x | x |
| Return Fan Command | | | | x | | | | x | | x |
| Return Fan Output (Fixed %) | | x | | | | | | x | | x |
| Return Fan Amps | x | | | | | | | x | | x |
| Return Fan Status | | | | | | | x | x | x | x |
| Motion Sensor Status | | | | | | | x | x | | x |
| Low Temperature Alarm | | | x | | | | | x | x | x |
| Effective Occupancy | | | | | | | x | x | | x |
| Occupied Schedule | | | | | | | x | x | | x |
| Occupancy Override | | | | | | | x | | | x |
| Recirc Enable | | | | | | | x | x | | x |
| Return Air Temperature | x | | | | | | | x | | x |
| Mixed Air Temperature | x | | | | | | | x | x | x |
| Return Air CO2 | x | | | | | | | x | x | x |
| Filter Differential Pressure | x | | | | | | | x | x | x |
| OA Damper Minimum Position | | | | | x | | | | | x |
| OA Damper Maximum CO2 Reset Limit | | | | | x | | | | | |
| Effective OA Damper Minimum Position | | | | | x | | | x | | x |
| Heating Valve Output | | x | | | | | | x | | x |
| Cooling Stage 1 Command | | | | x | | | | x | | x |
| Cooling Stage 2 Command | | | | x | | | | x | | x |
| Cooling Stage 3 Command | | | | x | | | | x | | x |
| Cooling Stage 4 Command | | | | x | | | | x | | x |
| Cooling Stage 5 Command | | | | x | | | | x | | x |
| Cooling Stage 6 Command | | | | x | | | | x | | x |
| Occupied Cooling Setpoint | | | | | x | | | x | | x |
| Unoccupied Cooling Setpoint | | | | | x | | | x | | x |
| Standby Cooling Setpoint | | | | | x | | | x | | x |
| Effective Cooling Setpoint | | | | | x | | | x | | x |
| Mixed Air Damper Output | | x | | | | | | x | | x |
| Outdoor Air Temperature | | | | | x | | | x | | x |
| Warmup/Cooldown Command | | | | | | | x | x | | x |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Number of Heating Requests | | | | | x | | | x | | x |
| Number of Cooling Requests | | | | | x | | | x | | x |
| Highest Zone Temperature | | | | | x | | | x | | x |
| Lowest Zone Temperature | | | | | x | | | x | | x |
| Average Zone Temperature | | | | | x | | | x | | x |
| AHU State | | | | | | | x | x | | x |
| Economizer Switchover Setpoint | | | | | x | | | | | x |
| Cooling OA-T Lockout Setpoint | | | | | x | | | | | x |
| Heating OA-T Lockout Setpoint | | | | | x | | | | | x |
| Mixed Air Low Limit Setpoint | | | | | x | | | | | x |
| Supply Fan Kilowatts | x | | | | | | | x | | x |
| Supply Fan VFD Alarm | | | x | | | | | x | x | x |
| Return Fan Kilowatts | x | | | | | | | x | | x |
| Return Fan VFD Alarm | | | x | | | | | x | x | x |
| ERV Exhaust Air Temperature | x | | | | | | | x | | x |
| ERV Control | | | | x | | | | x | | x |
| ERV Modulation | | x | | | | | | x | | x |
| ERV Return Air Damper Output | | x | | | | | | x | | x |
| ERV Supply Air Temperature | x | | | | | | | x | | x |
| ERV Supply Air Damper Output | | x | | | | | | x | | x |

### 3.8 SEQUENCES OF OPERATION FOR AHU-2 – GYM MULTIZONE AIR HANDLING UNIT – CONSTANT VOLUME WITH DX COOLING, GLYCOL HEATING AND ENERGY RECOVERY

**Integration with Other Systems:**

Air Handling Unit will monitor heat and cool requests from associated zones as well as lowest, highest, and average zone temperatures.

**Run Conditions:**

Occupied - Scheduled:
The unit shall run when the time schedule is set to Occupied. During Occupied times the outside air dampers are enabled to provide a minimum percentage of outside air. See DCV sequence for details.

Standby - Scheduled:
The unit shall run when the time schedule is set to Standby. During Standby mode the minimum outside air % shall be 0%. DCV shall override the minimum outside air % if CO2 levels are above setpoint.

**Occupied** – Triggered by Motion Sensor:
When in Unoccupied mode, the unit shall turn on in Occupied Mode if the following conditions are true:

- Motion sensor control is true. This point is scheduled.
- AND the BAS has detected motion for a definable number of minutes (initially set to 2 minutes)

The unit shall have minimum on/off times of 30 minutes.

Unoccupied Mode (System Off):
The supply and return/exhaust fans will be off. The AHU's return air dampers shall be positioned for full recirculation, exhaust air and fresh air dampers shall be fully closed. The ERV's exhaust and return air dampers shall also be fully closed.

Warmup Mode:
Warmup mode shall be activated if either of the following conditions are true:

- If a zone temperature drops below 16°C during unoccupied hours. Warmup shall stay active until the zone reaches 18 deg C.
- OR the optimal start algorithm is requesting heating.

During warmup mode, the mixed air dampers shall be positioned for full recirculation and the discharge air setpoint shall be 32 deg C.

Cooldown Mode:
Cooldown Mode shall be activated if the optimal start algorithm is requesting cooling. During cooldown mode, the mixed air dampers shall be positioned for full recirculation unless free cooling is available. The discharge air setpoint shall be 13 deg C.

Optimal Start:
The unit shall start prior to scheduled occupancy based on the time necessary for the zones to reach their occupied setpoints. The start time shall automatically adjust based on changes in outside air temperature and zone temperatures. Optimal Start shall be limited to the following times:

- Heating: 2 hours prior to Occupancy
- Cooling: 1 hour prior to Occupancy

Freeze Protection:
The unit shall shut down and generate an alarm upon receiving a freezestat status.

Return Fan:
The return fan shall run anytime the unit is commanded to run, unless shutdown on safeties. To prevent short cycling, the return fan shall have a minimum runtime of 30 minutes. The return fan shall run at a fixed % (determined by balancer).

Supply Fan:
The supply fan shall start 10 seconds after receiving return fan status. The supply fan shall run at a fixed % (determined by balancer).

Discharge Air Temperature Setpoint Calculation:
The discharge air temperature setpoint shall be reset using the table below:

| Average Zone Temperature | Discharge Air Temperature Setpoint |
|---|---|
| 20°C | 24°C |
| 24°C | 13°C |

Additionally, the discharge air setpoint will be reset based on a weighted sum of heating and cooling requests. Every zone heating request shall add 2°C to the discharge air setpoint and every zone cooling request shall deduct 2°C from the discharge air setpoint.
The discharge air setpoint shall be limited to a maximum of 32°C and a minimum of 13°C.

Glycol Reheat Valve Control – Typical for Stage, North Gym, South Gym
The glycol reheat valve shall modulate to maintain the effective zone heating setpoint.
Heating shall be enabled whenever:

- The outdoor air temperature is less than 15°C.
- AND the supply fan status is on.

Setpoints:

- Occupied Mode: The reheat valve shall maintain
  - 20°C heating setpoint.

- Standby Mode: The reheat valve shall maintain
  - 19°C heating setpoint.

- Unoccupied Mode (night setback): The reheat valve shall maintain
  - 16°C heating setpoint.

The discharge air temperature downstream of each heating coil shall be monitored.

Demand Control Ventilation – CO2 control:
During Occupied mode, the outside air dampers shall maintain the return CO2 setpoint by modulating between the Area Outdoor Air Rate and the Combined Outdoor Air Rate (Area Outdoor Rate + People Outdoor Air Rate) defined in Table 6.1 of ASHRAE 62-1 (both in L/s). The balancer shall determine the corresponding outdoor air damper positions for each flow rate.

- **OA Damper Minimum Position =** Area Outdoor Air Rate (%)
- **OA Damper Maximum CO2 Reset Limit =** Combined Outdoor Air Rate (%)

The return/space CO2 setpoint shall be **1000 ppm**.

Economizer and ERV Operation:
Heating Mode

- The economizer dampers shall remain closed and ERV shall be commanded on.
- ERV SF and EF shall modulate as required to maintain DCV as noted.

Cooling

- If Outdoor Air Temperature < Return Air Temperature, the economizer dampers shall modulate between minimum and maximum position to maintain DCV as noted
- If Outdoor Air Temperature > Return Air Temperature, the ERV shall be commanded on, and modulate ERV SF and RF shall modulate as required to maintain DCV as noted.

Economizer:
The economizer dampers shall modulate to prevent the mixed air temperature from dropping below 10°C.

ERV:
The ERV dampers shall open upon BAS command to ERV.

Mechanical Cooling Control:
The controller shall stage the condenser to maintain

- 23°C average zone temperature during occupied mode
- 25°C average zone temperature during standby mode.
- 32°C average zone temperature during unoccupied mode.

The controller shall limit the discharge air temperature from dropping below 8 deg C while cooling is active. There shall be minimum on/off times of 5 minutes for each stage unless an alarm occurs.
Mechanical cooling shall be enabled whenever:

- The outside air temperature is greater than 18°C
- AND economizer is not available or is fully open.
- AND heating (if present) is not active.

Supply and Return Fan VFD Monitoring:
The supply and return fan VFDs shall have a hardwired start/stop signal from the BAS.
The BAS shall monitor the supply and return fan status via current sensors that are hardwired back to the BAS controller.

The following VFD points shall be monitored:

- Supply Fan VFD Alarm
- Return Fan VFD Alarm
- Supply Fan Kilowatts
- Return Fan Kilowatts

Filter Monitoring:
The differential pressure across the filters shall be monitored. An alarm shall be generated if the differential pressure is greater than 250 Pa for 5 minutes.

**Alarms:**

- Return Fan Status: Mismatch between the fan command and the fan status for 30 minutes.
- Supply Fan Status: Mismatch between the fan command and the fan status for 30 minutes.
- Low Discharge Air Temperature: If the discharge air temperature is less than 5°C for 5 minutes and the supply fan status is on.
- High Discharge Air Temperature: If the discharge air temperature is more than 49°C for 5 minutes and the supply fan status is on.
- Low Mixed Air Temperature: If the mixed air temperature is less than 5°C for 5 minutes and the supply fan status is on.
- Dirty Filter Alarm: Differential pressure is greater than 250 Pa for 5 minutes.
- High Return Air Carbon Dioxide Concentration: If the return air CO2 concentration is greater than 1100 ppm for 30 minutes and the supply fan status is on.
- Low Zone Temperature – Stage: Zone shall generate an alarm when its temperature drops below 10°C for 30 minutes.
- Low Zone Temperature – North Gym: Zone shall generate an alarm when its temperature drops below 10°C for 30 minutes.
- Low Zone Temperature – South Gym: Zone shall generate an alarm when its temperature drops below 10°C for 30 minutes.
- Supply Fan VFD Alarm
- Return Fan VFD Alarm
- Temperature Low Limit Alarm

**Points:**

| BAS Points | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Point Name | Hardware Points | | | | Software Points | | | Trend | Alarm | Show on Graphic |
| | AI | AO | BI | BO | AV | BV | MV | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Discharge Air Temperature | x | | | | | | | x | x | x |
| Discharge Air Temperature Setpoint | | | | | x | | | x | | x |
| Supply Fan Command | | | | x | | | | x | | x |
| Supply Fan Output (Fixed %) | | x | | | | | | x | | x |
| Supply Fan Amps | x | | | | | | | x | | x |
| Supply Fan Status | | | | | | | x | x | x | x |
| Return Fan Command | | | | x | | | | x | | x |
| Return Fan Output (Fixed %) | | x | | | | | | x | | x |
| Return Fan Amps | x | | | | | | | x | | x |
| Return Fan Status | | | | | | | x | x | x | x |
| North Gym Motion Sensor | | | x | | | | | x | | x |
| South Gym Motion Sensor | | | x | | | | | x | | x |
| North Gym Zone Temperature | x | | | | | | | x | x | x |
| North Gym Discharge Air Temperature | x | | | | | | | x | | x |
| North Gym Reheat Valve Output | | x | | | | | | x | | x |
| North Gym Occupied Heating Setpoint | | | | | x | | | | | x |
| North Gym Unoccupied Heating Setpoint | | | | | x | | | | | x |
| North Gym Standby Heating Setpoint | | | | | x | | | | | x |
| North Gym Effective Heating Setpoint | | | | | x | | | | | x |
| South Gym Zone Temperature | x | | | | | | | x | x | x |
| South Gym Discharge Air Temperature | x | | | | | | | x | | x |
| South Gym Reheat Valve Output | | x | | | | | | x | | x |
| South Gym Occupied Heating Setpoint | | | | | x | | | | | x |
| South Gym Unoccupied Heating Setpoint | | | | | x | | | | | x |
| South Gym Standby Heating Setpoint | | | | | x | | | | | x |
| South Gym Effective Heating Setpoint | | | | | x | | | | | x |
| Stage Zone Temperature | x | | | | | | | x | x | x |
| Stage Discharge Air Temperature | x | | | | | | | x | | x |
| Stage Reheat Valve Output | | x | | | | | | x | | x |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Stage Occupied Heating Setpoint | | | | | x | | | | | x |
| Stage Unoccupied Heating Setpoint | | | | | x | | | | | x |
| Stage Standby Heating Setpoint | | | | | x | | | | | x |
| Stage Effective Heating Setpoint | | | | | x | | | | | x |
| Low Temperature Alarm | | | x | | | | | x | x | x |
| Effective Occupancy | | | | | | | x | x | | x |
| Occupied Schedule | | | | | | | x | x | | x |
| Occupancy Override | | | | | | | x | | | x |
| Recirc Enable | | | | | | | x | x | | x |
| Return Air Temperature | x | | | | | | | x | | x |
| Mixed Air Temperature | x | | | | | | | x | x | x |
| Return Air CO2 | x | | | | | | | x | x | x |
| Filter Differential Pressure | x | | | | | | | x | x | x |
| OA Damper Minimum Position | | | | | x | | | | | x |
| OA Damper Maximum CO2 Reset Limit | | | | | x | | | | | |
| Effective OA Damper Minimum Position | | | | | x | | | x | | x |
| Heating Valve Output | | x | | | | | | x | | x |
| Cooling Stage 1 Command | | | | x | | | | x | | x |
| Cooling Stage 2 Command | | | | x | | | | x | | x |
| Cooling Stage 3 Command | | | | x | | | | x | | x |
| Occupied Cooling Setpoint | | | | | x | | | x | | x |
| Unoccupied Cooling Setpoint | | | | | x | | | x | | x |
| Standby Cooling Setpoint | | | | | x | | | x | | x |
| Effective Cooling Setpoint | | | | | x | | | x | | x |
| Mixed Air Damper Output | | x | | | | | | x | | x |
| Outdoor Air Temperature | | | | | x | | | x | | x |
| Warmup/Cooldown Command | | | | | | | x | x | | x |
| Number of Heating Requests | | | | | x | | | x | | x |
| Number of Cooling Requests | | | | | x | | | x | | x |
| Highest Zone Temperature | | | | | x | | | x | | x |
| Lowest Zone Temperature | | | | | x | | | x | | x |
| Average Zone Temperature | | | | | x | | | x | | x |
| AHU State | | | | | | | x | x | | x |
| Economizer Switchover Setpoint | | | | | x | | | | | x |
| Cooling OA-T Lockout Setpoint | | | | | x | | | | | x |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Heating OA-T Lockout Setpoint | | | | | x | | | | | x |
| Mixed Air Low Limit Setpoint | | | | | x | | | | | x |
| Supply Fan Kilowatts | x | | | | | | | x | | x |
| Supply Fan VFD Alarm | | | x | | | | | x | x | x |
| Return Fan Kilowatts | x | | | | | | | x | | x |
| Return Fan VFD Alarm | | | x | | | | | x | x | x |
| ERV Exhaust Air Temperature | x | | | | | | | x | | x |
| ERV Control | | | | x | | | | x | | x |
| ERV Modulation | | x | | | | | | x | | x |
| ERV Return Air Damper Output | | x | | | | | | x | | x |
| ERV Supply Air Temperature | x | | | | | | | x | | x |
| ERV Supply Air Damper Output | | x | | | | | | x | | x |

### 3.9 SEQUENCES OF OPERATION FOR AHU-3 – SOUTH ADDITION CLASSROOMS MULTIZONE AIR HANDLING UNIT – CONSTANT VOLUME WITH DX COOLING AND GLYCOL HEATING

**Integration with Other Systems:**

Air Handling Unit will monitor heat and cool requests from associated zones as well as lowest, highest, and average zone temperatures.

**Run Conditions:**

Occupied - Scheduled:
The unit shall run when the time schedule is set to Occupied. During Occupied times the outside air dampers are enabled to provide a minimum percentage of outside air. See DCV sequence for details.

Standby - Scheduled:
The unit shall run when the time schedule is set to Standby. During Standby mode the minimum outside air % shall be 0%. DCV shall override the minimum outside air % if CO2 levels are above setpoint.

**Standby** – Triggered by Motion Sensor:
When in Unoccupied mode, the unit shall turn on in Standby Mode if the following conditions are true:

- Motion sensor control is true. This point is scheduled.
- AND the BAS has detected motion in a definable number of zones (initially set to 2).

During Standby mode the minimum outside air % shall be 0%. DCV shall override the minimum outside air % if CO2 levels are above setpoint.
The unit shall have minimum on/off times of 30 minutes.

Unoccupied Mode (System Off):
The supply and return/exhaust fans will be off. The return air dampers shall be positioned for full recirculation, exhaust air and fresh air dampers shall be fully closed.

Warmup Mode:
Warmup mode shall be activated if either of the following conditions are true:

- If a zone temperature drops below 16°C during unoccupied hours. Warmup shall stay active until the zone reaches 18 deg C.

- OR the optimal start algorithm is requesting heating.

During warmup mode, the mixed air dampers shall be positioned for full recirculation and the discharge air setpoint shall be 32 deg C.

Cooldown Mode:
Cooldown Mode shall be activated if the optimal start algorithm is requesting cooling. During cooldown mode, the mixed air dampers shall be positioned for full recirculation unless free cooling is available. The discharge air setpoint shall be 13 deg C.

Optimal Start:
The unit shall start prior to scheduled occupancy based on the time necessary for the zones to reach their occupied setpoints. The start time shall automatically adjust based on changes in outside air temperature and zone temperatures. Optimal Start shall be limited to the following times:

- Heating: 2 hours prior to Occupancy
- Cooling: 1 hour prior to Occupancy

Freeze Protection:
The unit shall shut down and generate an alarm upon receiving a freezestat status.

Return Fan:
The return fan shall run anytime the unit is commanded to run, unless shutdown on safeties. To prevent short cycling, the return fan shall have a minimum runtime of 30 minutes. The return fan shall run at a fixed % (determined by balancer).

Supply Fan:
The supply fan shall start 10 seconds after receiving return fan status. The supply fan shall run at a fixed % (determined by balancer).

Discharge Air Temperature Setpoint Calculation:
The discharge air temperature setpoint shall be reset using the table below:

| Average Zone Temperature | Discharge Air Temperature Setpoint |
|---|---|
| 20°C | 22°C |
| 24°C | 13°C |

Additionally, the discharge air setpoint will be reset based on a weighted sum of heating and cooling requests. Every zone heating request shall add 0.2°C to the discharge air setpoint and every zone cooling request shall deduct 0.2°C from the discharge air setpoint.
The discharge air setpoint shall be limited to a maximum of 32°C and a minimum of 13°C.

Glycol Heating Valve Control:
The heating valve shall modulate to maintain the discharge air temperature setpoint. The heating valve and mixed air dampers shall modulate sequentially, without overlapping.
Heating shall be enabled whenever:

- The discharge air temperature is below the heating setpoint.
- AND the outdoor air temperature is less than 15°C.

When the system is off, the heating coil valve shall modulate to maintain a plenum temperature of 13°C.
The heating coil valve shall open 100% whenever the freezestat is in alarm.

Demand Control Ventilation – CO2 control:
During Occupied mode, the outside air dampers shall maintain the return CO2 setpoint by modulating between the Area Outdoor Air Rate and the Combined Outdoor Air Rate (Area Outdoor Rate + People Outdoor Air Rate)

defined in Table 6.1 of ASHRAE 62-1 (both in L/s). The balancer shall determine the corresponding outdoor air damper positions for each flow rate.

- **OA Damper Minimum Position =** Area Outdoor Air Rate (%)
- **OA Damper Maximum CO2 Reset Limit =** Combined Outdoor Air Rate (%)

The return/space CO2 setpoint shall be **1000 ppm**.

Economizer:
The controller shall allow the economizer dampers to modulate beyond their minimum position to maintain the discharge air temperature setpoint if the outdoor air temperature is less than 19°C.
An economizer damper ramp rate of 50 changes per minute shall limit the rate at which the mixed air dampers open once enabled.
The economizer dampers shall modulate to prevent the mixed air temperature from dropping below 10°C.

Mechanical Cooling Control:
The controller shall stage the condenser to maintain

- 23°C average zone temperature during occupied mode
- 25°C average zone temperature during standby mode.
- 32°C average zone temperature during unoccupied mode.

The controller shall limit the discharge air temperature from dropping below 8 deg C while cooling is active. There shall be minimum on/off times of 5 minutes for each stage.
Mechanical cooling shall be enabled whenever:

- The outside air temperature is greater than 18°C
- AND economizer is not available or is fully open.
- AND heating (if present) is not active.

Supply and Return Fan VFD Monitoring:
The supply and return fan VFDs shall have a hardwired start/stop signal from the BAS.
The BAS shall monitor the supply and return fan status via current sensors that are hardwired back to the BAS controller.

The following VFD points shall be monitored:

- Supply Fan VFD Alarm
- Return Fan VFD Alarm
- Supply Fan Kilowatts
- Return Fan Kilowatts

Filter Monitoring:
The differential pressure across the filters shall be monitored. An alarm shall be generated if the differential pressure is greater than 250 Pa for 5 minutes.

**Alarms:**

- Return Fan Status: Mismatch between the fan command and the fan status for 30 minutes.
- Supply Fan Status: Mismatch between the fan command and the fan status for 30 minutes.
- Reheat Pump Status: Mismatch between the fan command and the fan status for 30 minutes.
- Low Discharge Air Temperature: If the discharge air temperature is less than 5°C for 5 minutes and the supply fan status is on.
- High Discharge Air Temperature: If the discharge air temperature is more than 49°C for 5 minutes and the supply fan status is on.
- Low Mixed Air Temperature: If the mixed air temperature is less than 5°C for 5 minutes and the supply fan status is on.
- Dirty Filter Alarm: Differential pressure is greater than 250 Pa for 5 minutes.

- High Return Air Carbon Dioxide Concentration: If the return air CO2 concentration is greater than 1100 ppm for 30 minutes and the supply fan status is on.
- Supply Fan VFD Alarm
- Return Fan VFD Alarm

**Points:**

| BAS Points | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Point Name | Hardware Points | | | | Software Points | | | Trend | Alarm | Show on Graphic |
| | AI | AO | BI | BO | AV | BV | MV | | | |
| Discharge Air Temperature | x | | | | | | | x | x | x |
| Discharge Air Temperature Setpoint | | | | | x | | | x | | x |
| Supply Fan Command | | | | x | | | | x | | x |
| Supply Fan Output (Fixed %) | | x | | | | | | x | | x |
| Supply Fan Amps | x | | | | | | | x | | x |
| Supply Fan Status | | | | | | | x | x | x | x |
| Return Fan Command | | | | x | | | | x | | x |
| Return Fan Output (Fixed %) | | x | | | | | | x | | x |
| Return Fan Amps | x | | | | | | | x | | x |
| Return Fan Status | | | | | | | x | x | x | x |
| Motion Sensor Status | | | | | | | x | x | | x |
| Low Temperature Alarm | | | x | | | | | x | x | x |
| Reheat Pump Command | | | | x | | | | x | | x |
| Reheat Pump Amps | x | | | | | | | x | | x |
| Reheat Pump Status | | | | | | | x | x | x | |
| Effective Occupancy | | | | | | | x | x | | x |
| Occupied Schedule | | | | | | | x | x | | x |
| Occupancy Override | | | | | | | x | | | x |
| Recirc Enable | | | | | | | x | x | | x |
| Return Air Temperature | x | | | | | | | x | | x |
| Mixed Air Temperature | x | | | | | | | x | x | x |
| Return Air CO2 | x | | | | | | | x | x | x |
| Filter Differential Pressure | x | | | | | | | x | x | x |
| OA Damper Minimum Position | | | | | x | | | | | x |
| OA Damper Maximum CO2 Reset Limit | | | | | x | | | | | |
| Effective OA Damper Minimum Position | | | | | x | | | x | | x |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Heating Valve Output | | x | | | | | | x | | x |
| Cooling Stage 1 Command | | | | x | | | | x | | x |
| Cooling Stage 2 Command | | | | x | | | | x | | x |
| Cooling Stage 3 Command | | | | x | | | | x | | x |
| Cooling Stage 4 Command | | | | x | | | | x | | x |
| Occupied Cooling Setpoint | | | | | x | | | x | | x |
| Unoccupied Cooling Setpoint | | | | | x | | | x | | x |
| Standby Cooling Setpoint | | | | | x | | | x | | x |
| Effective Cooling Setpoint | | | | | x | | | x | | x |
| Mixed Air Damper Output | | x | | | | | | x | | x |
| Outdoor Air Temperature | | | | | x | | | x | | x |
| Warmup/Cooldown Command | | | | | | | x | x | | x |
| Number of Heating Requests | | | | | x | | | x | | x |
| Number of Cooling Requests | | | | | x | | | x | | x |
| Highest Zone Temperature | | | | | x | | | x | | x |
| Lowest Zone Temperature | | | | | x | | | x | | x |
| Average Zone Temperature | | | | | x | | | x | | x |
| AHU State | | | | | | | x | x | | x |
| Economizer Switchover Setpoint | | | | | x | | | | | x |
| Cooling OA-T Lockout Setpoint | | | | | x | | | | | x |
| Heating OA-T Lockout Setpoint | | | | | x | | | | | x |
| Mixed Air Low Limit Setpoint | | | | | x | | | | | x |
| Supply Fan Kilowatts | x | | | | | | | x | | x |
| Supply Fan VFD Alarm | | | x | | | | | x | x | x |
| Return Fan Kilowatts | x | | | | | | | x | | x |
| Return Fan VFD Alarm | | | x | | | | | x | x | x |

### 3.10 SEQUENCES OF OPERATION FOR AHU-4 – ADMINISTRATION MULTIZONE AIR HANDLING UNIT – CONSTANT VOLUME WITH GLYCOL HEATING AND HEAT PUMP

**Integration with Other Systems:**

Air Handling Unit will monitor heat and cool requests from associated zones as well as lowest, highest, and average zone temperatures.

**Run Conditions:**

Occupied - Scheduled:
The unit shall run when the time schedule is set to Occupied. During Occupied times the outside air dampers are enabled to provide a minimum percentage of outside air. See DCV sequence for details.

Standby - Scheduled:
Issued for Addendum #3

The unit shall run when the time schedule is set to Standby. During Standby mode the minimum outside air % shall be 0%. DCV shall override the minimum outside air % if CO2 levels are above setpoint.

**Standby** – Triggered by Motion Sensor:
When in Unoccupied mode, the unit shall turn on in Standby Mode if the following conditions are true:

- Motion sensor control is true. This point is scheduled.
- AND the BAS has detected motion in a definable number of zones (initially set to 2).

During Standby mode the minimum outside air % shall be 0%. DCV shall override the minimum outside air % if CO2 levels are above setpoint.
The unit shall have minimum on/off times of 30 minutes.

Unoccupied Mode (System Off):
The supply and return/exhaust fans will be off. The return air dampers shall be positioned for full recirculation, exhaust air and fresh air dampers shall be fully closed.

Warmup Mode:
Warmup mode shall be activated if either of the following conditions are true:

- If a zone temperature drops below 16°C during unoccupied hours. Warmup shall stay active until the zone reaches 18 deg C.
- OR the optimal start algorithm is requesting heating.

During warmup mode, the mixed air dampers shall be positioned for full recirculation and the discharge air setpoint shall be 32 deg C.

Cooldown Mode:
Cooldown Mode shall be activated if the optimal start algorithm is requesting cooling. During cooldown mode, the mixed air dampers shall be positioned for full recirculation unless free cooling is available. The discharge air setpoint shall be 13 deg C.

Optimal Start:
The unit shall start prior to scheduled occupancy based on the time necessary for the zones to reach their occupied setpoints. The start time shall automatically adjust based on changes in outside air temperature and zone temperatures. Optimal Start shall be limited to the following times:

- Heating: 2 hours prior to Occupancy
- Cooling: 1 hour prior to Occupancy

Freeze Protection:
The unit shall shut down and generate an alarm upon receiving a freezestat status.

Return Fan:
The return fan shall run anytime the unit is commanded to run, unless shutdown on safeties. To prevent short cycling, the return fan shall have a minimum runtime of 30 minutes. The return fan shall run at a fixed % (determined by balancer).

Supply Fan:
The supply fan shall start 10 seconds after receiving return fan status. The supply fan shall run at a fixed % (determined by balancer).

Discharge Air Temperature Setpoint Calculation:
The discharge air temperature setpoint shall be reset using the table below:

Average Zone Temperature Discharge Air Temperature Setpoint

| | |
|---|---|
| 20°C | 22°C |
| 24°C | 13°C |

Additionally, the discharge air setpoint will be reset based on a weighted sum of heating and cooling requests. Every zone heating request shall add 0.2°C to the discharge air setpoint and every zone cooling request shall deduct 0.2°C from the discharge air setpoint.
The discharge air setpoint shall be limited to a maximum of 32°C and a minimum of 13°C.

Heat Pump Control (Heating):
The heat pump shall be enabled for heating when:

- The discharge air temperature is below the heating setpoint.
- AND the outdoor air temperature is less than 15°C.
- AND the outdoor air temperature is above -5°C.

The BAS shall modulate the heat pump capacity signal to maintain discharge air temperature setpoint.

Heat Pump Control Cooling:
The heat pump shall be enabled for cooling when:

- The average zone temperature is above 23°C during occupied mode
- OR the average zone temperature is above 25°during standby mode.
- Or the average zone temperature is above 32° during unoccupied mode.
- AND the outside air temperature is greater than 18°C
- AND economizer is not available or is fully open.
- AND heating (if present) is not active.
- AND the supply fan status is on.

The BAS shall modulate the heat pump capacity signal to maintain discharge air temperature setpoint.

Heat pump monitoring:
The following points shall be monitored:

- Fan Interlock
- Heat Pump On/Off Status
- Heat Pump Defrost Mode Status
- Heat Pump Alarm

Glycol Heating Valve Control:
The heating valve shall modulate to maintain the discharge air temperature setpoint. The heating valve and mixed air dampers shall modulate sequentially, without overlapping.
Heating shall be enabled whenever:

- The discharge air temperature is below the heating setpoint.
- AND the outdoor air temperature is less than 15°C.
- AND Heat Pump Control is not enabled

When the system is off, the heating coil valve shall modulate to maintain a plenum temperature of 13°C.
The heating coil valve shall open 100% whenever the freezestat is in alarm.

Demand Control Ventilation – CO2 control:
During Occupied mode, the outside air dampers shall maintain the return CO2 setpoint by modulating between the Area Outdoor Air Rate and the Combined Outdoor Air Rate (Area Outdoor Rate + People Outdoor Air Rate) defined in Table 6.1 of ASHRAE 62-1 (both in L/s). The balancer shall determine the corresponding outdoor air damper positions for each flow rate.

- **OA Damper Minimum Position =** Area Outdoor Air Rate (%)

- **OA Damper Maximum CO2 Reset Limit =** Combined Outdoor Air Rate (%)

The return/space CO2 setpoint shall be **1000 ppm**.

Economizer:
The controller shall allow the economizer dampers to modulate beyond their minimum position to maintain the discharge air temperature setpoint if the outdoor air temperature is less than 19°C.
An economizer damper ramp rate of 50 changes per minute shall limit the rate at which the mixed air dampers open once enabled.
The economizer dampers shall modulate to prevent the mixed air temperature from dropping below 10°C.

Supply and Return Fan VFD Monitoring:
The supply and return fan VFDs shall have a hardwired start/stop signal from the BAS.
The BAS shall monitor the supply and return fan status via current sensors that are hardwired back to the BAS controller.

The following VFD points shall be monitored:
- Supply Fan VFD Alarm
- Return Fan VFD Alarm
- Supply Fan Kilowatts
- Return Fan Kilowatts

Filter Monitoring:
The differential pressure across the filters shall be monitored. An alarm shall be generated if the differential pressure is greater than 250 Pa for 5 minutes.

**Alarms:**

- Return Fan Status: Mismatch between the fan command and the fan status for 30 minutes.
- Supply Fan Status: Mismatch between the fan command and the fan status for 30 minutes.
- Reheat Pump Status: Mismatch between the fan command and the fan status for 30 minutes.
- Low Discharge Air Temperature: If the discharge air temperature is less than 5°C for 5 minutes and the supply fan status is on.
- High Discharge Air Temperature: If the discharge air temperature is more than 49°C for 5 minutes and the supply fan status is on.
- Low Mixed Air Temperature: If the mixed air temperature is less than 5°C for 5 minutes and the supply fan status is on.
- Dirty Filter Alarm: Differential pressure is greater than 250 Pa for 5 minutes.
- High Return Air Carbon Dioxide Concentration: If the return air CO2 concentration is greater than 1100 ppm for 30 minutes and the supply fan status is on.
- Supply Fan VFD Alarm
- Return Fan VFD Alarm
- Heat Pump Unit Alarm

**Points:**

| BAS Points | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Point Name | Hardware Points | | | | Software Points | | | Trend | Alarm | Show on Graphic |
| | AI | AO | BI | BO | AV | BV | MV | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Discharge Air Temperature | x | | | | | | | x | x | x |
| Discharge Air Temperature Setpoint | | | | | x | | | x | | x |
| Supply Fan Command | | | | x | | | | x | | x |
| Supply Fan Output (Fixed %) | | x | | | | | | x | | x |
| Supply Fan Amps | x | | | | | | | x | | x |
| Supply Fan Status | | | | | | | x | x | x | x |
| Return Fan Command | | | | x | | | | x | | x |
| Return Fan Output (Fixed %) | | x | | | | | | x | | x |
| Return Fan Amps | x | | | | | | | x | | x |
| Return Fan Status | | | | | | | x | x | x | x |
| Motion Sensor Status | | | | | | | x | x | | x |
| Low Temperature Alarm | | | x | | | | | x | x | x |
| Heat Pump OA-T Lockout Setpoint | | | | | x | | | x | | x |
| Effective Occupancy | | | | | | | x | x | | x |
| Occupied Schedule | | | | | | | x | x | | x |
| Occupancy Override | | | | | | | x | | | x |
| Recirc Enable | | | | | | | x | x | | x |
| Return Air Temperature | x | | | | | | | x | | x |
| Mixed Air Temperature | x | | | | | | | x | x | x |
| Return Air CO2 | x | | | | | | | x | x | x |
| Filter Differential Pressure | x | | | | | | | x | x | x |
| OA Damper Minimum Position | | | | | x | | | | | x |
| OA Damper Maximum CO2 Reset Limit | | | | | x | | | | | |
| Effective OA Damper Minimum Position | | | | | x | | | x | | x |
| Heating Valve Output | | x | | | | | | x | | x |
| Occupied Cooling Setpoint | | | | | x | | | x | | x |
| Unoccupied Cooling Setpoint | | | | | x | | | x | | x |
| Standby Cooling Setpoint | | | | | x | | | x | | x |
| Effective Cooling Setpoint | | | | | x | | | x | | x |
| Heat Pump Command | | | | x | | | | x | | x |
| Cooling/Heating Output Capacity | | x | | | | | | x | | x |
| Cooling/Heating Mode | | | | x | | | | x | | x |
| Fan Interlock | | | x | | | | | x | | x |
| Heat Pump On/Off Status | | | x | | | | | x | | x |
| Heat Pump Defrost Mode Status | | | x | | | | | x | | x |
| Heat Pump Alarm | | | x | | | | | x | x | x |
| Mixed Air Damper Output | | x | | | | | | x | | x |
| Outdoor Air Temperature | | | | | x | | | x | | x |
| Warmup/Cooldown Command | | | | | | | x | x | | x |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Number of Heating Requests | | | | | x | | | x | | x |
| Number of Cooling Requests | | | | | x | | | x | | x |
| Highest Zone Temperature | | | | | x | | | x | | x |
| Lowest Zone Temperature | | | | | x | | | x | | x |
| Average Zone Temperature | | | | | x | | | x | | x |
| AHU State | | | | | | | x | x | | x |
| Economizer Switchover Setpoint | | | | | x | | | | | x |
| Cooling OA-T Lockout Setpoint | | | | | x | | | | | x |
| Heating OA-T Lockout Setpoint | | | | | x | | | | | x |
| Mixed Air Low Limit Setpoint | | | | | x | | | | | x |
| Supply Fan Kilowatts | x | | | | | | | x | | x |
| Supply Fan VFD Alarm | | | x | | | | | x | x | x |
| Return Fan Kilowatts | x | | | | | | | x | | x |
| Return Fan VFD Alarm | | | x | | | | | x | x | x |

### 3.11 SEQUENCES OF OPERATION FOR AHU-5 – SERVERY AND EAST CAFETERIA TRANE FAN COIL UNIT – CONSTANT VOLUME WITH DX COOLING AND GLYCOL HEATING

Run Conditions – Scheduled:
The unit shall run according to a user definable time schedule in the following modes:

- Occupied Mode: The unit shall maintain
  - 23°C cooling setpoint
  - 21°C heating setpoint.

- Standby Mode: The unit shall maintain
  - 25°C cooling setpoint
  - 19°C heating setpoint.

- Unoccupied Mode (night setback): The unit shall maintain
  - 32°C cooling setpoint.
  - 16°C heating setpoint.

Occupied – Scheduled:
The unit shall run when the time schedule is set to Occupied. During Occupied mode the fresh air damper shall be enabled if AHU-1 supply fan status is on.

Standby - Scheduled:
The unit shall run when the time schedule is set to Standby. During Standby mode the fresh air damper shall be disabled.

**Occupied** – Triggered by Motion Sensor:
When in Unoccupied mode, the unit shall turn on in Occupied Mode if the following conditions are true:

- Motion sensor control is true. This point is scheduled.
- AND the BAS has detected motion for a definable number of minutes (initially set to 2 minutes)

The unit shall have minimum on/off times of 30 minutes.

Unoccupied Heating/Cooling:
The unit shall cycle to maintain the Unoccupied heating and cooling setpoints. During Unoccupied hours the fresh air damper shall be disabled.

Zone Optimal Start:
The unit shall use an optimal start algorithm for morning start-up. This algorithm shall minimize the unoccupied warm-up or cool-down period while still achieving comfort conditions by the start of scheduled occupied period. Optimal Start shall be limited to the following times:

- Heating: 2 hours prior to Occupancy
- Cooling: 1 hour prior to Occupancy

The outside air damper shall be disabled during optimal start.

Supply Fan:
The supply fan shall run anytime the unit is commanded to run. To prevent short cycling, the supply fan shall have a minimum runtime of 30 minutes.

Discharge Air Temperature Monitoring:
The controller shall monitor the discharge air temperature.

Return Air Temperature Monitoring:
The controller shall monitor the return air temperature.

Glycol Reheat Valve Control:
The glycol valve shall modulate to maintain the effective zone heating setpoint.
Heating shall be enabled whenever:

- The outdoor air temperature is less than 15°C.
- AND the supply fan status is on.

Mechanical Cooling Control:
The cooling stages shall be controlled to maintain the effective zone cooling setpoint. There shall be a user definable delay between stages, and each stage shall have a user definable minimum runtime.
Cooling shall be enabled whenever:

- The outside air temperature is greater than 13°C.
- AND the supply fan status is on.
- AND the heating (if present) is not active.

Filter Monitoring:
The differential pressure across the filters shall be monitored. An alarm shall be generated if the differential pressure is greater than 250 Pa for 5 minutes.

**Alarms:**

- Low Zone Temperature: Zone shall generate an alarm when its temperature drops below 10°C for 30 minutes.
- Supply Fan Status: Mismatch between the fan command and the fan status for 30 minutes.
- Low Discharge Air Temperature: If the discharge air temperature is less than 5°C for 5 minutes and the supply fan status is on.
- High Discharge Air Temperature: If the discharge air temperature is more than 49°C for 5 minutes and the supply fan status is on.
- Low Zone Temperature – Zone shall generate an alarm when its temperature drops below 10°C for 30 minutes.

- Dirty Filter Alarm: Differential pressure is greater than 250 Pa for 5 minutes.

**Points:**

| BAS Points | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Point Name | Hardware Points | | | | Software Points | | | Trend | Alarm | Show on Graphic |
| | AI | AO | BI | BO | AV | BV | MV | | | |
| Zone Temperature | x | | | | | | | x | x | x |
| Discharge Air Temperature | x | | | | | | | x | x | x |
| Supply Fan Command | | | | x | | | | x | | x |
| Supply Fan Amps | x | | | | | | | x | | x |
| Supply Fan Status | | | | | | | x | x | x | x |
| Motion Sensor Status | | | x | | | | | x | | x |
| Effective Occupancy | | | | | | | x | x | | x |
| Occupied Schedule | | | | | | | x | x | | x |
| Occupancy Override | | | | | | | x | | | x |
| Damper Enable | | | | x | | | | x | | x |
| Return Air Temperature | x | | | | | | | x | | x |
| Effective Heating Setpoint | | | | | x | | | x | | x |
| Effective Cooling Setpoint | | | | | x | | | x | | x |
| Occupied Heating Setpoint | | | | | x | | | | | x |
| Occupied Cooling Setpoint | | | | | x | | | | | x |
| Standby Heating Setpoint | | | | | x | | | | | x |
| Standby Cooling Setpoint | | | | | x | | | | | x |
| Unoccupied Heating Setpoint | | | | | x | | | | | x |
| Unoccupied Cooling Setpoint | | | | | x | | | | | x |
| Heating Valve Output | | x | | | | | | x | | x |
| Cooling Stage 1 Command | | | | x | | | | x | | x |
| Cooling Stage 2 Command | | | | x | | | | x | | x |
| Outdoor Air Temperature | | | | | x | | | x | | x |
| Warmup/Cooldown Command | | | | | | | x | x | | x |
| AHU State | | | | | | | x | x | | x |
| Cooling OA-T Lockout Setpoint | | | | | x | | | | | x |
| Heating OA-T Lockout Setpoint | | | | | x | | | | | x |
| Filter Differential Pressure | x | | | | | | | x | x | x |

### 3.12 SEQUENCES OF OPERATION FOR MAU-1 – KITCHEN REZNOR MAKEUP AIR UNIT – CONSTANT VOLUME WITH DX COOLING AND GAS HEATING

Run Conditions – Scheduled:
The unit and associated kitchen hood fan shall run according to a user definable time schedule.

**Unit Control:**

The heating and cooling shall be controlled by the unit's local controls.

Supply Fan Monitoring:
The controller shall monitor the supply fan current.

Exhaust Fan Monitoring:
The controller shall monitor the kitchen hood exhaust fan current.

Discharge Air Temperature Monitoring:
The controller shall monitor the discharge air temperature.

Zone Temperature Monitoring:
The controller shall monitor the zone temperature.

Filter Monitoring:
The differential pressure across the filters shall be monitored. An alarm shall be generated if the differential pressure is greater than 250 Pa for 5 minutes.

**Alarms:**

- Low Zone Temperature: Zone shall generate an alarm when its temperature drops below 10°C for 30 minutes.
- Supply Fan Status: Mismatch between unit enable and the fan status for 30 minutes.
- Exhaust Fan Status: Mismatch unit enable and the fan status for 30 minutes.
- Low Discharge Air Temperature: If the discharge air temperature is less than 5°C for 5 minutes and the supply fan status is on.
- High Discharge Air Temperature: If the discharge air temperature is more than 49°C for 5 minutes and the supply fan status is on.
- Low Zone Temperature – Zone shall generate an alarm when its temperature drops below 10°C for 30 minutes.
- Dirty Filter Alarm: Differential pressure is greater than 250 Pa for 5 minutes.

**Points:**

| BAS Points | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Point Name | Hardware Points | | | | Software Points | | | Trend | Alarm | Show on Graphic |
| | AI | AO | BI | BO | AV | BV | MV | | | |
| Zone Temperature | x | | | | | | | x | x | x |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Discharge Air Temperature | x | | | | | | | x | x | x |
| Unit Enable | | | | x | | | | x | | x |
| Supply Fan Amps | x | | | | | | | x | | x |
| Supply Fan Status | | | | | | | x | x | x | x |
| Kitchen Hood Exhaust Fan Amps | x | | | | | | | x | | x |
| Kitchen Hood Exhaust Fan Status | | | | | | | x | x | x | x |
| Effective Occupancy | | | | | | | x | x | | x |
| Occupied Schedule | | | | | | | x | x | | x |
| Occupancy Override | | | | | | | x | | | x |
| Outdoor Air Temperature | | | | | x | | | x | | x |
| Filter Differential Pressure | x | | | | | | | x | x | x |

### 3.13 SEQUENCES OF OPERATION FOR CENTRAL HEATING PLANT - 4 MODULATING BOILERS

Integration with Other Systems:
Hot water system will monitor heat requests from associated zones.

Hot Water System Run Conditions:
The hot water boiler system shall operate in two modes, auto and manual.
When in manual, the hot water boiler system is enabled to run, regardless of the season, outdoor air temperature and zone heating demands.

When in auto, the hot water boiler system is enabled to run when:

- The summer/winter point is set to winter
- AND there is a definable number of zones that need heating (initially set to 10)
- AND the outdoor air temperature is less than 15°C.

For freeze protection, the boiler system shall always be enabled to run whenever the outside air temperature is less than 5°C regardless of the number of zones that need heating, mode or season.
The boiler system shall run for a minimum time of 60 minutes to prevent short cycling.

Hot Water Temperature Setpoint:
The hot water supply temperature setpoint shall reset based on outside air temperature by using the table below (adj.):

| Outdoor Air Temperature | Hot Water Supply Setpoint |
|---|---|
| -10°C | 80°C |
| 5°C | 60°C |

Every zone heating request shall add 0.2°C (adj.) to the supply water reset schedule. The supply water setpoint shall be limited to a maximum of 82°C and a minimum of 60°C.
The following temperatures shall be monitored:

- hot water supply temperature.
- hot water return temperature.

Boiler Lead/Lag Operation:
The 4 boilers shall operate in a lead/lag fashion.
The controller shall monitor the building's hot water supply temperature and stage the boilers in sequence to maintain the supply temperature setpoint.

- The lead boiler shall start first and modulate to maintain the hot water supply temperature.
- As the hot water temperature begins to fall and the lead boiler approaches maximum firing rate, the second boiler shall enable and operate in parallel with the lead boiler.
- If additional heating capacity is required, the third boiler shall start and operate in unison with the others.
- If further capacity is still required, the fourth boiler shall start and run in unison with the operating boilers.
- As the hot water supply temperature rises above setpoint and the boilers modulate toward minimum fire, the lag boilers shall shut down one at a time.
- The system shall continue shedding boilers until the remaining boiler(s) can maintain the supply temperature at setpoint.
- On failure of the lead boiler, or if locked out by the operator through a designated maintenance switch, the next lag boiler shall run and the lead boiler shall turn off.

The designated lead boiler shall rotate upon one of the following conditions: (user selectable):

- equal run time
- weekly schedule

Boiler 1 Monitoring:
The following boiler points shall be monitored:

- Boiler 1 leaving hot water temperature.
- Boiler 1 entering hot water temperature.
- Boiler 1 status.
- Boiler 1 alarm.

Boiler 2 Monitoring:
The following boiler points shall be monitored:

- Boiler 2 leaving hot water temperature.
- Boiler 2 entering hot water temperature.
- Boiler 2 status.
- Boiler 2 alarm.

Boiler 3 Monitoring:
The following boiler points shall be monitored:

- Boiler 1 leaving hot water temperature.
- Boiler 1 entering hot water temperature.
- Boiler 1 status.
- Boiler 1 alarm.

Boiler 4 Monitoring:
The following boiler points shall be monitored:

- Boiler 2 leaving hot water temperature.
- Boiler 2 entering hot water temperature.
- Boiler 2 status.
- Boiler 2 alarm.

Boiler 1 Circulation Pump 1 Control:
Boiler 1 circulation pump shall run anytime boiler 1 is called to run and shall run 10 minutes after the boiler has stopped.

Boiler 2 Circulation Pump 2 Control:
Boiler 2 circulation pump shall run anytime boiler 2 is called to run and shall run 10 minutes after the boiler has stopped.

Boiler 3 Circulation Pump 3 Control:
Boiler 3 circulation pump shall run anytime boiler 3 is called to run and shall run 10 minutes after the boiler has stopped.

Boiler 4 Circulation Pump 4 Control:
Boiler 4 circulation pump shall run anytime boiler 4 is called to run and shall run 10 minutes after the boiler has stopped.

Hot Water Pump Control:
Hot water pumps 9 and 10 shall operate in a lead/lag fashion and the lead pump shall run continuously when the boiler system is enabled.

- On failure of the lead pump, or if locked out by the operator through a designated maintenance switch, the standby pump shall run and the lead pump shall turn off.
- The lead hot water pump shall run for 1 hour after system shutdown.

The designated lead pump shall rotate upon one of the following conditions (user selectable):

- equal run time
- weekly schedule

Heating Flag:
The Heating Flag shall be true when:

- The hot water supply temperature is above 37°C.
- AND the status of either building hot water pump is on.

**Alarms:**

- Low Hot Water Supply Temperature: If the boiler system has been enabled for 1 hour and the hot water supply temperature is less than 37°C for 30 minutes.
- Boiler 1 Alarm: Hardwired output from the boiler to the BAS indicating an alarm.
- Boiler 2 Alarm: Hardwired output from the boiler to the BAS indicating an alarm.
- Boiler 3 Alarm: Hardwired output from the boiler to the BAS indicating an alarm.
- Boiler 4 Alarm: Hardwired output from the boiler to the BAS indicating an alarm.
- Boiler 1 Circ Pump 1 Status: Mismatch between the pump command and pump status for 30 minutes.
- Boiler 2 Circ Pump 2 Status: Mismatch between the pump command and pump status for 30 minutes.
- Boiler 3 Circ Pump 3 Status: Mismatch between the pump command and pump status for 30 minutes.
- Boiler 4 Circ Pump 4 Status: Mismatch between the pump command and pump status for 30 minutes.
- Hot Water Pump 9 Status: Mismatch between the pump command and the pump status for 30 minutes.
- Hot Water Pump 10 Status: Mismatch between the pump command and the pump status for 30 minutes.

**Points:**

| BAS Points | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Point Name | Hardware Points | | | | Software Points | | | Trend | Alarm | Show on Graphic |
| | AI | AO | BI | BO | AV | BV | MV | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Hot Water Supply Temperature | x | | | | | | | x | x | x |
| Hot Water Return Temperature | x | | | | | | | x | | x |
| Hot Water Supply Temperature Setpoint | | | | | x | | | x | | x |
| Outdoor Air Temperature | x | | | | | | | x | | x |
| Boiler 1 Command | | | | x | | | | x | | x |
| Boiler 1 Output | | x | | | | | | x | | x |
| Boiler 1 Status | | | x | | | | | x | | x |
| Boiler 1 Alarm | | | x | | | | | x | x | x |
| Boiler 1 Maintenance Switch | | | | | | | x | x | | x |
| Boiler 1 Entering Water Temperature | x | | | | | | | x | | x |
| Boiler 1 Leaving Water Temperature | x | | | | | | | x | | x |
| Boiler 2 Command | | | | x | | | | x | | x |
| Boiler 2 Output | | x | | | | | | x | | x |
| Boiler 2 Status | | | x | | | | | x | | x |
| Boiler 2 Alarm | | | x | | | | | x | x | x |
| Boiler 2 Maintenance Switch | | | | | | | x | x | | x |
| Boiler 2 Entering Water Temperature | x | | | | | | | x | | x |
| Boiler 2 Leaving Water Temperature | x | | | | | | | x | | x |
| Boiler 3 Command | | | | x | | | | x | | x |
| Boiler 3 Output | | x | | | | | | x | | x |
| Boiler 3 Status | | | x | | | | | x | | x |
| Boiler 3 Alarm | | | x | | | | | x | x | x |
| Boiler 3 Maintenance Switch | | | | | | | x | x | | x |
| Boiler 3 Entering Water Temperature | x | | | | | | | x | | x |
| Boiler 3 Leaving Water Temperature | x | | | | | | | x | | x |
| Boiler 4 Command | | | | x | | | | x | | x |
| Boiler 4 Output | | x | | | | | | x | | x |
| Boiler 4 Status | | | x | | | | | x | | x |
| Boiler 4 Alarm | | | x | | | | | x | x | x |
| Boiler 4 Maintenance Switch | | | | | | | x | x | | x |
| Boiler 4 Entering Water Temperature | x | | | | | | | x | | x |
| Boiler 4 Leaving Water Temperature | x | | | | | | | x | | x |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Boiler 1 Circ. Pump Command | | | | x | | | | x | | x |
| Boiler 1 Circ. Pump Amperage | x | | | | | | | x | | x |
| Boiler 1 Circ. Pump Status | | | | | | | x | x | x | x |
| Boiler 1 Circ. Pump Failed to Start Alarm | | | | | | | x | x | x | x |
| Boiler 2 Circ. Pump Command | | | | x | | | | x | | x |
| Boiler 2 Circ. Pump Amperage | x | | | | | | | x | | x |
| Boiler 2 Circ. Pump Status | | | | | | | x | x | x | x |
| Boiler 2 Circ. Pump Failed to Start Alarm | | | | | | | x | x | x | x |
| Boiler 3 Circ. Pump Command | | | | x | | | | x | | x |
| Boiler 3 Circ. Pump Amperage | x | | | | | | | x | | x |
| Boiler 3 Circ. Pump Status | | | | | | | x | x | x | x |
| Boiler 3 Circ. Pump Failed to Start Alarm | | | | | | | x | x | x | x |
| Boiler 4 Circ. Pump Command | | | | x | | | | x | | x |
| Boiler 4 Circ. Pump Amperage | x | | | | | | | x | | x |
| Boiler 4 Circ. Pump Status | | | | | | | x | x | x | x |
| Boiler 4 Circ. Pump Failed to Start Alarm | | | | | | | x | x | x | x |
| Hot Water Pump 9 Command | | | | x | | | | x | | x |
| Hot Water Pump 9 Output | | x | | | | | | x | | x |
| Hot Water Pump 9 Amperage | x | | | | | | | x | | x |
| Hot Water Pump 9 Status | | | | | | | x | x | x | x |
| Hot Water Pump 9 Failed to Start Alarm | | | | | | | x | x | x | x |
| Hot Water Pump 9 Maintenance Switch | | | | | | | x | x | | x |
| Hot Water Pump 10 Command | | | | x | | | | x | | x |
| Hot Water Pump 10 Output | | x | | | | | | x | | x |
| Hot Water Pump 10 Amperage | x | | | | | | | x | | x |
| Hot Water Pump 10 Status | | | | | | | x | x | x | x |
| Hot Water Pump 10 Failed to Start Alarm | | | | | | | x | x | x | x |
| Hot Water Pump 10 Maintenance Switch | | | | | | | x | x | | x |
| Season | | | | | | | x | x | | x |
| Hot Water System Available | | | | | | | x | x | | x |
| Heating Flag | | | | | | | x | x | | x |
| Number of Heating Requests | | | | | x | | | x | | x |
| Application Mode | | | | | | | x | x | | x |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Heating OA-T Lockout Setpoint | | | | | x | | | | | x |
| Heating OA-T Low Temperature Setpoint | | | | | x | | | | | x |
| Heating Request Setpoint | | | | | x | | | | | x |
| Heating Flag | | | | | | | x | x | | |
| System Reset | | | | | | | x | | | x |

### 3.14 SEQUENCES OF OPERATION FOR HEAT EXCHANGER 1 - MAIN SCHOOL

**Glycol Heating System Run Conditions:**
The glycol system shall run whenever the heating plant is on.

Heat Exchanger 1 Glycol Pump 7 and 8 Control:
Glycol pumps 7 and 8 shall operate in a lead/lag fashion and the lead pump shall run continuously when the boiler system is enabled.

- On failure of the lead pump, or if locked out by the operator through a designated maintenance switch, the standby pump shall run and the lead pump shall turn off.
- The lead glycol pump shall run for 1 hour after system shutdown.

The designated lead pump shall rotate upon one of the following conditions (user selectable):

- equal run time
- weekly schedule

Heat Exchanger 1 Temperature Monitoring:
The following temperatures shall be monitored:

- heat exchanger 1 hot water entering temperature
- heat exchanger 1 hot water leaving temperature
- heat exchanger 1 glycol entering temperature.
- heat exchanger 1 glycol leaving temperature.

**Alarms:**

- Glycol Pump 7 Status: Mismatch between the pump command and the pump status for 30 minutes.
- Glycol Pump 8 Status: Mismatch between the pump command and the pump status for 30 minutes.
- Heat Exchanger 1 Low Glycol Leaving Temperature: If the boiler system has been enabled for 1 hour and the glycol supply temperature is less than 37°C for 30 minutes.

**Points:**

| BAS Points | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Point Name | Hardware Points | | | | Software Points | | | Trend | Alarm | Show on Graphic |
| | AI | AO | BI | BO | AV | BV | MV | | | |
| Outdoor Air Temperature | | | | | x | | | x | | x |
| Glycol Pump 7 Command | | | | x | | | | x | | x |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Glycol Pump 7 Amperage | x | | | | | | | x | | x |
| Glycol Pump 7 Status | | | | | | | x | x | x | x |
| Glycol Pump 7 Failed to Start Alarm | | | | | | | x | x | x | x |
| Glycol Pump 7 Maintenance Switch | | | | | | | x | x | | x |
| Glycol Pump 8 Command | | | | x | | | | x | | x |
| Glycol Pump 8 Amperage | x | | | | | | | x | | x |
| Glycol Pump 8 Status | | | | | | | x | x | x | x |
| Glycol Pump 8 Failed to Start Alarm | | | | | | | x | x | x | x |
| Glycol Pump 8 Maintenance Switch | | | | | | | x | x | | x |
| Heat Exchanger 1 Hot Water Entering Temp | x | | | | | | | x | | x |
| Heat Exchanger 1 Hot Water Leaving Temp | x | | | | | | | x | | x |
| Heat Exchanger 1 Glycol Entering Temp | x | | | | | | | x | | x |
| Heat Exchanger 1 Glycol Leaving Temp | x | | | | | | | x | x | x |
| System Reset | | | | | | | x | | | x |

### 3.15 SEQUENCES OF OPERATION FOR HEAT EXCHANGER 2 - NORTH ADDITION

Glycol Heating System Run Conditions:
The glycol system shall run whenever the heating plant is on.

Heat Exchanger 2 Glycol Pump 5 and 6 Control:
Glycol pumps 5 and 6 shall operate in a lead/lag fashion and the lead pump shall run continuously when the boiler system is enabled.

- On failure of the lead pump, or if locked out by the operator through a designated maintenance switch, the standby pump shall run and the lead pump shall turn off.
- The lead glycol pump shall run for 1 hour after system shutdown.

The designated lead pump shall rotate upon one of the following conditions (user selectable):

- equal run time
- weekly schedule

Heat Exchanger 2 Temperature Monitoring:
The following temperatures shall be monitored:

- heat exchanger 2 hot water entering temperature
- heat exchanger 2 hot water leaving temperature
- heat exchanger 2 glycol entering temperature.
- heat exchanger 2 glycol leaving temperature.

**Alarms:**

Issued for Addendum #3

- Glycol Pump 5 Status: Mismatch between the pump command and the pump status for 30 minutes.
- Glycol Pump 6 Status: Mismatch between the pump command and the pump status for 30 minutes.
- Heat Exchanger 2 Low Glycol Leaving Temperature: If the boiler system has been enabled for 1 hour and the glycol supply temperature is less than 37°C for 30 minutes.

**Points:**

| BAS Points | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Point Name | Hardware Points | | | | Software Points | | | Trend | Alarm | Show on Graphic |
| | AI | AO | BI | BO | AV | BV | MV | | | |
| Outdoor Air Temperature | | | | | x | | | x | | x |
| Glycol Pump 5 Command | | | | x | | | | x | | x |
| Glycol Pump 5 Amperage | x | | | | | | | x | | x |
| Glycol Pump 5 Status | | | | | | | x | x | x | x |
| Glycol Pump 5 Failed to Start Alarm | | | | | | | x | x | x | x |
| Glycol Pump 5 Maintenance Switch | | | | | | | x | x | | x |
| Glycol Pump 6 Command | | | | x | | | | x | | x |
| Glycol Pump 6 Amperage | x | | | | | | | x | | x |
| Glycol Pump 6 Status | | | | | | | x | x | x | x |
| Glycol Pump 6 Failed to Start Alarm | | | | | | | x | x | x | x |
| Glycol Pump 6 Maintenance Switch | | | | | | | x | x | | x |
| Heat Exchanger 2 Hot Water Entering Temp | x | | | | | | | x | | x |
| Heat Exchanger 2 Hot Water Leaving Temp | x | | | | | | | x | | x |
| Heat Exchanger 2 Glycol Entering Temp | x | | | | | | | x | | x |
| Heat Exchanger 2 Glycol Leaving Temp | x | | | | | | | x | x | x |
| System Reset | | | | | | | x | | | x |

### 3.16 SEQUENCES OF OPERATION FOR HEAT EXCHANGER 3 - SOUTH ADDITION AHU-3

**Glycol System Run Conditions:**
The glycol pump shall start when AHU-3 heating valve is greater than 10% open and shall turn off when the heating valve is closed. The pump shall run continuously if the outdoor air temperature is below 5°C.

**Alarms:**

- Pump Status: Mismatch between the pump command and the pump status for 30 minutes.
- Heat Exchanger 3 Low Glycol Leaving Temperature: If the boiler system has been enabled for 1 hour and glycol pump 10 is commanded on and the glycol supply temperature is less than 37°C for 30 minutes.

**Points:**

| BAS Points | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Point Name | Hardware Points | | | | Software Points | | | Trend | Alarm | Show on Graphic |
| | AI | AO | BI | BO | AV | BV | MV | | | |
| Outdoor Air Temperature | | | | | x | | | x | | x |
| Glycol Pump 10 Command | | | | x | | | | x | | x |
| Glycol Pump 10 Amperage | x | | | | | | | x | | x |
| Glycol Pump 10 Status | | | | | | | x | x | x | x |
| Heat Exchanger 3 Hot Water Entering Temp | | | | | x | | | x | | x |
| Heat Exchanger 3 Hot Water Leaving Temp | | | | | x | | | x | | x |
| Heat Exchanger 3 Glycol Entering Temp | x | | | | | | | x | | x |
| Heat Exchanger 3 Glycol Leaving Temp | x | | | | | | | x | x | x |

### 3.17 SEQUENCES OF OPERATION FOR HYDRONIC REHEAT COIL WITH RADIANT PERIMETER HEATING

**Run Conditions - Scheduled:**
The unit shall run according to a user definable time schedule in the following modes:

- Occupied Mode: The unit shall maintain
  - 21°C heating setpoint.
  - 23°C cooling setpoint.

- Standby Mode: The unit shall maintain
  - 19°C heating setpoint.
  - 25°C cooling setpoint.

- Unoccupied Mode (night setback): The unit shall maintain
  - 16°C heating setpoint.
  - 32°C cooling setpoint.

Perimeter Heating Valve:
The controller shall measure the zone temperature and modulate the perimeter heating valve open on dropping temperature to maintain its heating setpoint.

Reheat Coil Valve:
The controller shall measure the zone temperature and modulate the reheat coil valve open on dropping temperature to maintain its heating setpoint. The perimeter heating valve shall be the first to open.

Zone Temperature Adjust:

The occupant shall be able to adjust the heating setpoint locally by +/- 1°C.

Motion Sensing:
The controller shall monitor motion. If motion is detected the controller shall report the motion to it's associated AHU.

Discharge Air Temperature Monitoring:
The controller shall monitor the discharge air temperature downstream of the heating coil.

Zone Optimal Start:
The unit shall use an optimal start algorithm for morning start-up. This algorithm shall minimize the unoccupied warm-up period while still achieving comfort conditions by the start of scheduled occupied period.

Heating Request:
A zone shall generate a heating request when it's heating PID is greater than 80% (differential 50%).

Cooling Request:
A zone shall generate a cooling request when the zone temperature is greater than the effective cooling setpoint (differential 0.5 deg C).

**Alarms:**

- Low Zone Temperature: A zone shall generate an alarm when its temperature drops below 10°C for 30 minutes.

**Points:**

| BAS Points | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Point Name | Hardware Points | | | | Software Points | | | Trend | Alarm | Show on Graphic |
| | AI | AO | BI | BO | AV | BV | MV | | | |
| Zone Temperature | x | | | | | | | x | x | x |
| Warmer/Cooler Adjust | x | | | | | | | x | | x |
| Zone Temporary Occupancy | | | x | | | | | x | | x |
| Motion Sensor | | | x | | | | | x | | x |
| Discharge Air Temperature | x | | | | | | | x | | x |
| Outdoor Air Temperature | | | | | x | | | x | | x |
| Occupied Schedule | | | | | | | x | x | | x |
| Effective Occupancy | | | | | | | x | x | | x |
| Occupancy Override | | | | | | | x | | | x |
| Effective Heating Setpoint | | | | | x | | | x | | x |
| Effective Cooling Setpoint | | | | | x | | | x | | x |
| Occupied Heating Setpoint | | | | | x | | | | | x |
| Occupied Cooling Setpoint | | | | | x | | | | | x |
| Standby Heating Setpoint | | | | | x | | | | | x |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Standby Cooling Setpoint | | | | | x | | | | | x |
| Unoccupied Heating Setpoint | | | | | x | | | | | x |
| Unoccupied Cooling Setpoint | | | | | x | | | | | x |
| Reheat Valve Output | | x | | | | | | x | | x |
| Perimeter Heating Valve Output | | x | | | | | | x | | x |
| Heating Request Source | | | | | x | | | x | | |
| Cooling Request Source | | | | | x | | | x | | |

### 3.18 SEQUENCES OF OPERATION FOR HYDRONIC REHEAT COIL

The unit shall run according to a user definable time schedule in the following modes:

- Occupied Mode: The unit shall maintain
  - 21°C heating setpoint.
  - 23°C cooling setpoint.

- Standby Mode: The unit shall maintain
  - 19°C heating setpoint.
  - 25°C cooling setpoint.

- Unoccupied Mode (night setback): The unit shall maintain
  - 16°C heating setpoint.
  - 32°C cooling setpoint.

Reheat Coil Valve:
The controller shall measure the zone temperature and modulate the reheat coil valve open on dropping temperature to maintain its heating setpoint.

Zone Temperature Adjust:
The occupant shall be able to adjust the heating setpoint locally by +/- 1°C.

Motion Sensing:
The controller shall monitor motion. If motion is detected the controller shall report the motion to it's associated AHU.

Discharge Air Temperature Monitoring:
The controller shall monitor the discharge air temperature downstream of the heating coil.

Zone Optimal Start:
The unit shall use an optimal start algorithm for morning start-up. This algorithm shall minimize the unoccupied warm-up period while still achieving comfort conditions by the start of scheduled occupied period.

Heating Request:
A zone shall generate a heating request when it's heating PID is greater than 80% (differential 50%).

Cooling Request:
A zone shall generate a cooling request when the zone temperature is greater than the effective cooling setpoint (differential 0.5 deg C).

**Alarms:**

Issued for Addendum #3

- Low Zone Temperature: A zone shall generate an alarm when its temperature drops below 10°C for 30 minutes.

**Points:**

| BAS Points | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Point Name | Hardware Points | | | | Software Points | | | Trend | Alarm | Show on Graphic |
| | AI | AO | BI | BO | AV | BV | MV | | | |
| Zone Temperature | x | | | | | | | x | x | x |
| Warmer/Cooler Adjust | x | | | | | | | x | | x |
| Zone Temporary Occupancy | | | x | | | | | x | | x |
| Motion Sensor | | | x | | | | | x | | x |
| Discharge Air Temperature | x | | | | | | | x | | x |
| Outdoor Air Temperature | | | | | x | | | x | | x |
| Occupied Schedule | | | | | | | x | x | | x |
| Effective Occupancy | | | | | | | x | x | | x |
| Occupancy Override | | | | | | | x | | | x |
| Effective Heating Setpoint | | | | | x | | | x | | x |
| Effective Cooling Setpoint | | | | | x | | | x | | x |
| Occupied Heating Setpoint | | | | | x | | | | | x |
| Occupied Cooling Setpoint | | | | | x | | | | | x |
| Standby Heating Setpoint | | | | | x | | | | | x |
| Standby Cooling Setpoint | | | | | x | | | | | x |
| Unoccupied Heating Setpoint | | | | | x | | | | | x |
| Unoccupied Cooling Setpoint | | | | | x | | | | | x |
| Reheat Valve Output | | x | | | | | | x | | x |
| Heating Request Source | | | | | x | | | x | | |
| Cooling Request Source | | | | | x | | | x | | |

### 3.19 SEQUENCES OF OPERATION FOR HYDRONIC REHEAT COIL - CORRIDOR

The unit shall run according to a user definable time schedule in the following modes:

- Occupied Mode: The unit shall maintain
  - 21°C heating setpoint.
  - 23°C cooling setpoint.

- Standby Mode: The unit shall maintain
  - 19°C heating setpoint.
  - 25°C cooling setpoint.

- Unoccupied Mode (night setback): The unit shall maintain
  - 16°C heating setpoint.
  - 32°C cooling setpoint.

Reheat Coil Valve:
The controller shall measure the zone temperature and modulate the reheat coil valve open on dropping temperature to maintain its heating setpoint.

Discharge Air Temperature Monitoring:
The controller shall monitor the discharge air temperature downstream of the heating coil.

Zone Optimal Start:
The unit shall use an optimal start algorithm for morning start-up. This algorithm shall minimize the unoccupied warm-up period while still achieving comfort conditions by the start of scheduled occupied period.

Heating Request:
A zone shall generate a heating request when it's heating PID is greater than 80% (differential 50%).

Cooling Request:
A zone shall generate a cooling request when the zone temperature is greater than the effective cooling setpoint (differential 0.5 deg C).

**Alarms:**

- Low Zone Temperature: A zone shall generate an alarm when its temperature drops below 10°C for 30 minutes.

**Points:**

| BAS Points | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Point Name | Hardware Points | | | | Software Points | | | Trend | Alarm | Show on Graphic |
| | AI | AO | BI | BO | AV | BV | MV | | | |
| Zone Temperature | x | | | | | | | x | x | x |
| Discharge Air Temperature | x | | | | | | | x | | x |
| Outdoor Air Temperature | | | | | x | | | x | | x |
| Occupied Schedule | | | | | | | x | x | | x |
| Effective Occupancy | | | | | | | x | x | | x |
| Occupancy Override | | | | | | | x | | | x |
| Effective Heating Setpoint | | | | | x | | | x | | x |
| Effective Cooling Setpoint | | | | | x | | | x | | x |
| Occupied Heating Setpoint | | | | | x | | | | | x |
| Occupied Cooling Setpoint | | | | | x | | | | | x |
| Standby Heating Setpoint | | | | | x | | | | | x |
| Standby Cooling Setpoint | | | | | x | | | | | x |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Unoccupied Heating Setpoint | | | | | x | | | | | x |
| Unoccupied Cooling Setpoint | | | | | x | | | | | x |
| Reheat Valve Output | | x | | | | | | x | | x |
| Heating Request Source | | | | | x | | | x | | |
| Cooling Request Source | | | | | x | | | x | | |

### 3.20 SEQUENCES OF OPERATION FOR HYDRONIC RADIANT/WALLFIN HEATER

**Run Conditions - Scheduled:**
The unit shall run according to a user definable time schedule in the following modes:

- Occupied Mode: The unit shall maintain
  - 20°C heating setpoint.

- Unoccupied Mode (night setback): The unit shall maintain
  - 16°C heating setpoint.

Perimeter Heating Valve:
The controller shall measure the zone temperature and modulate the perimeter heating valve open on dropping temperature to maintain its heating setpoint.

Zone Optimal Start:
The unit shall use an optimal start algorithm for morning start-up. This algorithm shall minimize the unoccupied warm-up period while still achieving comfort conditions by the start of scheduled occupied period.

Heating Request:
A zone shall generate a heating request when it's heating PID is greater than 80% (differential 50%).

**Alarms:**

- Low Zone Temperature: A zone shall generate an alarm when its temperature drops below 10°C for 30 minutes.

**Points:**

| BAS Points | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Point Name | Hardware Points | | | | Software Points | | | Trend | Alarm | Show on Graphic |
| | AI | AO | BI | BO | AV | BV | MV | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Zone Temperature | x | | | | | | | x | x | x |
| Outdoor Air Temperature | | | | | x | | | x | | x |
| Occupied Schedule | | | | | | | x | x | | x |
| Effective Occupancy | | | | | | | x | x | | x |
| Occupancy Override | | | | | | | x | | | x |
| Effective Heating Setpoint | | | | | x | | | x | | x |
| Occupied Heating Setpoint | | | | | x | | | | | x |
| Unoccupied Heating Setpoint | | | | | x | | | | | x |
| Perimeter Heating Valve Output | | x | | | | | | x | | x |
| Heating Request Source | | | | | x | | | x | | |

### 3.21 SEQUENCES OF OPERATION FOR HYDRONIC FORCE FLOW HEATER

**Run Conditions:**
The unit shall maintain
21°C heating setpoint.

Fan:
The fan shall run anytime the zone temperature drops below heating setpoint **and the heating flag is true.**

Fan Amperage:
The controller shall monitor the fan amperage.

**Alarms:**

- Low Zone Temperature: A zone shall generate an alarm when its temperature drops below 10°C for 30 minutes.

**Points:**

| BAS Points | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Point Name | Hardware Points | | | | Software Points | | | Trend | Alarm | Show on Graphic |
| | AI | AO | BI | BO | AV | BV | MV | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Zone Temperature | x | | | | | | | x | x | x |
| Outdoor Air Temperature | | | | | x | | | x | | x |
| Heating Setpoint | | | | | x | | | | | x |
| Forced Flow Heater Command | | | | x | | | | x | | x |
| Forced Flow Heater Amps | x | | | | | | | x | | x |
| Heating Flag | | | | | | | x | x | | x |

### 3.22 SEQUENCES OF OPERATION FOR HYDRONIC UNIT HEATER

**Run Conditions - Scheduled:**
The unit shall run according to a user definable time schedule in the following modes:

- Occupied Mode: The unit shall maintain
  - 20°C heating setpoint.

- Unoccupied Mode (night setback): The unit shall maintain
  - 16°C heating setpoint.

Heater:
The heater shall run anytime the zone temperature drops below heating setpoint **and the heating flag is true.**

Heater Amperage:
The controller shall monitor the forced flow heater amperage.

**Alarms:**

- Low Zone Temperature: A zone shall generate an alarm when its temperature drops below 10°C for 30 minutes.

**Points:**

| BAS Points | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Point Name | Hardware Points | | | | Software Points | | | Trend | Alarm | Show on Graphic |
| | AI | AO | BI | BO | AV | BV | MV | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Zone Temperature | x | | | | | | | x | x | x |
| Outdoor Air Temperature | | | | | x | | | x | | x |
| Occupied Schedule | | | | | | | x | x | | x |
| Effective Occupancy | | | | | | | x | x | | x |
| Occupancy Override | | | | | | | x | | | x |
| Effective Heating Setpoint | | | | | x | | | x | | x |
| Occupied Heating Setpoint | | | | | x | | | | | x |
| Unoccupied Heating Setpoint | | | | | x | | | | | x |
| Unit Heater Command | | | | x | | | | x | | x |
| Unit Heater Amps | x | | | | | | | x | | x |
| Heating Flag | | | | | | | x | x | | x |

### 3.23 SEQUENCES OF OPERATION FOR ELECTRIC UNIT/FORCE FLOW HEATER

**Run Conditions - Scheduled:**
The unit shall run according to a user definable time schedule in the following modes:

- Occupied Mode: The unit shall maintain
  - 20°C heating setpoint.

- Unoccupied Mode (night setback): The unit shall maintain
  - 16°C heating setpoint.

Heater:
The heater shall run anytime the zone temperature drops below heating setpoint.

Heater Amperage:
The controller shall monitor the forced flow heater amperage.

**Alarms:**

- Low Zone Temperature: A zone shall generate an alarm when its temperature drops below 10°C for 30 minutes.

**Points:**

| BAS Points | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Point Name | Hardware Points | | | | Software Points | | | Trend | Alarm | Show on Graphic |
| | AI | AO | BI | BO | AV | BV | MV | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Zone Temperature | x | | | | | | | x | x | x |
| Outdoor Air Temperature | | | | | x | | | x | | x |
| Occupied Schedule | | | | | | | x | x | | x |
| Effective Occupancy | | | | | | | x | x | | x |
| Occupancy Override | | | | | | | x | | | x |
| Effective Heating Setpoint | | | | | x | | | x | | x |
| Occupied Heating Setpoint | | | | | x | | | | | x |
| Unoccupied Heating Setpoint | | | | | x | | | | | x |
| Heater Command | | | | x | | | | x | | x |
| Heater Amps | x | | | | | | | x | | x |
| Covers Electric UH and FFH. | | | | | | | | | | |

### 3.24 SEQUENCES OF OPERATION FOR EXHAUST FAN WITH HYDRONIC UNIT/FORCE FLOW HEATER

**Run Conditions - Scheduled:**
The units shall be enabled according to a user definable time schedule in the following modes:

- Occupied Mode: The units shall maintain
  - 25°C cooling setpoint.
  - 20°C heating setpoint.

- Unoccupied Mode (night setback): The units shall maintain
  - 29°C cooling setpoint.
  - 16°C heating setpoint.

Exhaust Fan:
The exhaust fan shall run anytime the zone temperature rises above the cooling setpoint.

Exhaust Fan Amperage:
The controller shall monitor the exhaust fan amperage.

Heater:
The heater shall run anytime the zone temperature drops below heating setpoint **and the heating flag is true.**

Heater Amperage:
The controller shall monitor the heater amperage.

**Alarms:**

- Low Zone Temperature: A zone shall generate an alarm when its temperature drops below 10°C for 30 minutes.

**Points:**

| BAS Points |
|---|

| Point Name | Hardware Points | | | | Software Points | | | Trend | Alarm | Show on Graphic |
|---|---|---|---|---|---|---|---|---|---|---|
| | AI | AO | BI | BO | AV | BV | MV | | | |
| Zone Temperature | x | | | | | | | x | x | x |
| Outdoor Air Temperature | | | | | x | | | x | | x |
| Occupied Schedule | | | | | | | x | x | | x |
| Effective Occupancy | | | | | | | x | x | | x |
| Occupancy Override | | | | | | | x | | | x |
| Effective Heating Setpoint | | | | | x | | | x | | x |
| Effective Cooling Setpoint | | | | | x | | | x | | x |
| Occupied Heating Setpoint | | | | | x | | | | | x |
| Occupied Cooling Setpoint | | | | | x | | | | | x |
| Unoccupied Heating Setpoint | | | | | x | | | | | x |
| Unoccupied Cooling Setpoint | | | | | x | | | | | x |
| Heater Command | | | | x | | | | x | | x |
| Heater Amps | x | | | | | | | x | | x |
| Exhaust Fan Command (Starter) * | | | | x | | | | x | | x |
| Exhaust Fan Enable (Wall Switch) * | | | | x | | | | x | | x |
| Exhaust Fan Amps | x | | | | | | | x | | x |
| Heating Flag | | | | | | | x | x | | x |
| * Select 1 only. Command if controlled by starter, Enable if wall switch present | | | | | | | | | | |
| Covers Hydronic UH and FFH. | | | | | | | | | | |

### 3.25 SEQUENCES OF OPERATION FOR EXHAUST FAN WITH ELECTRIC UNIT/FORCE FLOW HEATER

**Run Conditions - Scheduled:**
The units shall be enabled according to a user definable time schedule in the following modes:

- Occupied Mode: The units shall maintain
  - 25°C cooling setpoint.
  - 20°C heating setpoint.

- Unoccupied Mode (night setback): The units shall maintain
  - 29°C cooling setpoint.
  - 16°C heating setpoint.

Exhaust Fan:
The exhaust fan shall run anytime the zone temperature rises above the cooling setpoint.

Exhaust Fan Amperage:
The controller shall monitor the exhaust fan amperage.

Heater:
The heater shall run anytime the zone temperature drops below heating setpoint and the heating flag is true.

Heater Amperage:
The controller shall monitor the heater amperage.

**Alarms:**

- Low Zone Temperature: A zone shall generate an alarm when its temperature drops below 10°C for 30 minutes.

**Points:**

| BAS Points | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Point Name | Hardware Points | | | | Software Points | | | Trend | Alarm | Show on Graphic |
| | AI | AO | BI | BO | AV | BV | MV | | | |
| Zone Temperature | x | | | | | | | x | x | x |
| Outdoor Air Temperature | | | | | x | | | x | | x |
| Occupied Schedule | | | | | | | x | x | | x |
| Effective Occupancy | | | | | | | x | x | | x |
| Occupancy Override | | | | | | | x | | | x |
| Effective Heating Setpoint | | | | | x | | | x | | x |
| Effective Cooling Setpoint | | | | | x | | | x | | x |
| Occupied Heating Setpoint | | | | | x | | | | | x |
| Occupied Cooling Setpoint | | | | | x | | | | | x |
| Unoccupied Heating Setpoint | | | | | x | | | | | x |
| Unoccupied Cooling Setpoint | | | | | x | | | | | x |
| Heater Command | | | | x | | | | x | | x |
| Heater Amps | x | | | | | | | x | | x |
| Exhaust Fan Command (Starter) * | | | | x | | | | x | | x |
| Exhaust Fan Enable (Wall Switch) * | | | | x | | | | x | | x |
| Exhaust Fan Amps | x | | | | | | | x | | x |
| Heating Flag | | | | | | | x | x | | x |
| * Select 1 only. Command if controlled by starter, Enable if wall switch present | | | | | | | | | | |
| Covers Electric UH and FFH. | | | | | | | | | | |

### 3.26 SEQUENCES OF OPERATION FOR VENT DAMPER WITH HYDRONIC UNIT HEATER

**Run Conditions - Scheduled:**
The units shall be enabled according to a user definable time schedule in the following modes:

- Occupied Mode: The units shall maintain
  - 25°C cooling setpoint.
  - 20°C heating setpoint.

- Unoccupied Mode (night setback): The units shall maintain
  - 29°C cooling setpoint.
  - 16°C heating setpoint.

Vent Damper:
The vent damper shall open anytime the zone temperature rises above the cooling setpoint.

Unit Heater:
The unit heater shall run anytime the zone temperature drops below heating setpoint **and the Heating Flag is true.**

Unit Heater Amperage:
The controller shall monitor the unit heater amperage.

**Alarms:**

- Low Zone Temperature: A zone shall generate an alarm when its temperature drops below 10°C for 30 minutes.

**Points:**

| BAS Points |
|---|

| Point Name | Hardware Points | | | | Software Points | | | Trend | Alarm | Show on Graphic |
|---|---|---|---|---|---|---|---|---|---|---|
| | AI | AO | BI | BO | AV | BV | MV | | | |
| Zone Temperature | x | | | | | | | x | x | x |
| Outdoor Air Temperature | | | | | x | | | x | | x |
| Occupied Schedule | | | | | | | x | x | | x |
| Effective Occupancy | | | | | | | x | x | | x |
| Occupancy Override | | | | | | | x | | | x |
| Effective Heating Setpoint | | | | | x | | | x | | x |
| Effective Cooling Setpoint | | | | | x | | | x | | x |
| Occupied Heating Setpoint | | | | | x | | | | | x |
| Occupied Cooling Setpoint | | | | | x | | | | | x |
| Unoccupied Heating Setpoint | | | | | x | | | | | x |
| Unoccupied Cooling Setpoint | | | | | x | | | | | x |
| Vent Damper Command | | | | x | | | | x | | x |
| Unit Heater Command | | | | x | | | | x | | x |
| Unit Heater Amps | x | | | | | | | x | | x |
| Heating Flag | | | | | | | x | x | | x |

### 3.27 SEQUENCES OF OPERATION FOR EXHAUST FAN – ZONE TEMPERATURE CONTROL

**Run Conditions - Scheduled:**
The unit shall be enabled according to a user definable time schedule in the following modes:

- Occupied Mode: The unit shall maintain
  - 25°C cooling setpoint.

- Unoccupied Mode (night setback): The unit shall maintain
  - 29°C cooling setpoint.

Fan:
The fan shall run anytime the zone temperature rises above the cooling setpoint.

Fan Amperage:
The controller shall monitor the exhaust fan amperage.

Exhaust Air Damper:
If a motorised exhaust air damper is present it shall be electrically interlocked with the exhaust fan start/stop.

**Alarms:**

- Low Zone Temperature: A zone shall generate an alarm when its temperature drops below 10°C for 30 minutes.

**Points:**

Issued for Addendum #3

| BAS Points | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Point Name | Hardware Points | | | | Software Points | | | Trend | Alarm | Show on Graphic |
| | AI | AO | BI | BO | AV | BV | MV | | | |
| Zone Temperature | x | | | | | | | x | x | x |
| Outdoor Air Temperature | | | | | x | | | x | | x |
| Occupied Schedule | | | | | | | x | x | | x |
| Effective Occupancy | | | | | | | x | x | | x |
| Occupancy Override | | | | | | | x | | | x |
| Effective Cooling Setpoint | | | | | x | | | x | | x |
| Occupied Cooling Setpoint | | | | | x | | | | | x |
| Unoccupied Cooling Setpoint | | | | | x | | | | | x |
| Exhaust Fan Command * | | | | x | | | | x | | x |
| Exhaust Fan Enable * | | | | x | | | | x | | x |
| Exhaust Fan Amps | x | | | | | | | x | | x |
| * Select 1 only. Command if controlled by starter, Enable if wall switch present | | | | | | | | | | |

### 3.28 SEQUENCES OF OPERATION FOR EXHAUST FAN – ZONE TEMPERATURE CONTROL WITH OUTDOOR AIR DAMPER

### 3.29 SEQUENCES OF OPERATION FOR EB-131 (CS03) RECYCLING ROOM

**Run Conditions - Scheduled:**
The unit shall be enabled according to a user definable time schedule in the following modes:

- Occupied Mode: The unit shall maintain
  - 25°C cooling setpoint.

- Unoccupied Mode (night setback): The unit shall maintain
  - 29°C cooling setpoint.

Fan:
The fan shall run anytime the zone temperature rises above the cooling setpoint.

Fan Amperage:
The controller shall monitor the exhaust fan amperage.

Exhaust Air Damper:
If a motorised exhaust air damper is present it shall be electrically interlocked with the exhaust fan start/stop.

Outdoor Air Damper:
The BAS shall open the associated outside air intake damper if the exhaust fan is running. The outdoor damper shall be closed when the exhaust fan is off.

**Alarms:**

- Low Zone Temperature: A zone shall generate an alarm when its temperature drops below 10°C for 30 minutes.

**Points:**

| BAS Points | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Point Name | Hardware Points | | | | Software Points | | | Trend | Alarm | Show on Graphic |
| | AI | AO | BI | BO | AV | BV | MV | | | |
| Zone Temperature | x | | | | | | | x | x | x |
| Outdoor Air Temperature | | | | | x | | | x | | x |
| Occupied Schedule | | | | | | | x | x | | x |
| Effective Occupancy | | | | | | | x | x | | x |
| Occupancy Override | | | | | | | x | | | x |
| Effective Cooling Setpoint | | | | | x | | | x | | x |
| Occupied Cooling Setpoint | | | | | x | | | | | x |
| Unoccupied Cooling Setpoint | | | | | x | | | | | x |
| Exhaust Fan Command * | | | | x | | | | x | | x |
| Exhaust Fan Enable * | | | | x | | | | x | | x |
| Exhaust Fan Amps | x | | | | | | | x | | x |
| Outside Air Damper Command | | | | x | | | | xx | | |
| * Select 1 only. Command if controlled by starter, Enable if wall switch present | | | | | | | | | | |

### 3.30 SEQUENCES OF OPERATION FOR EXHAUST FAN – ON/OFF OR ENABLE

**Run Conditions - Scheduled:**
The fan shall run according to a user definable time schedule.

Fan:
The fan shall run when the schedule is occupied.

Fan Amperage:
The controller shall monitor the exhaust fan amperage.

Exhaust Air Damper:
If a motorised exhaust air damper is present it shall be electrically interlocked with the exhaust fan start/stop.

**Points:**

| BAS Points |
|---|

| Point Name | Hardware Points | | | | Software Points | | | Trend | Alarm | Show on Graphic |
|---|---|---|---|---|---|---|---|---|---|---|
| | AI | AO | BI | BO | AV | BV | MV | | | |
| Outdoor Air Temperature | | | | | x | | | x | | x |
| Occupied Schedule | | | | | | | x | x | | x |
| Effective Occupancy | | | | | | | x | x | | x |
| Occupancy Override | | | | | | | x | | | x |
| Exhaust Fan Command * | | | | x | | | | x | | x |
| Exhaust Fan Enable * | | | | x | | | | x | | x |
| Exhaust Fan Amps | x | | | | | | | x | | x |
| *Command if controlled by starter, Enable if wall switch present | | | | | | | | | | |

### 3.31 SEQUENCES OF OPERATION FOR EF-71 AND SF-01 – FINISHING ROOM

**Run Conditions - Scheduled:**
The exhaust fan shall be enabled according to a user definable time schedule.

Exhaust Fan:
The exhaust fan shall be enabled when the schedule is occupied.

Exhaust Fan Amperage:
The controller shall monitor the exhaust fan amperage.

Exhaust Air Damper:
If a motorised exhaust air damper is present it shall be electrically interlocked with the exhaust fan start/stop.

Supply Fan:
The supply fan shall turn on if exhaust fan status is on and shall turn off if the exhaust fan status is off.

Exhaust Fan Amperage:
The controller shall monitor the supply fan amperage.

**Points:**

| BAS Points |
|---|

| Point Name | Hardware Points | | | | Software Points | | | Trend | Alarm | Show on Graphic |
|---|---|---|---|---|---|---|---|---|---|---|
| | AI | AO | BI | BO | AV | BV | MV | | | |
| Outdoor Air Temperature | | | | | x | | | x | | x |
| Occupied Schedule | | | | | | | x | x | | x |
| Effective Occupancy | | | | | | | x | x | | x |
| Occupancy Override | | | | | | | x | | | x |
| Exhaust Fan Enable | | | | x | | | | x | | x |
| Supply Fan Command | | | | x | | | | x | | x |
| Exhaust Fan Amps | x | | | | | | | x | | x |
| Supply Fan Amps | x | | | | | | | x | | x |

### 3.32 SEQUENCES OF OPERATION FOR LIGHTING - CORRIDORS

**Run Conditions:**
The corridor lighting shall be turned on if either of the following are true:

- The building alarm system is disarmed.
- OR there is an intruder alarm.
- OR there is a fire alarm.

**Points:**

| BAS Points | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Point Name | Hardware Points | | | | Software Points | | | Trend | Alarm | Show on Graphic |
| | AI | AO | BI | BO | AV | BV | MV | | | |
| Outdoor Air Temperature | | | | | x | | | x | | x |
| Security System Armed Status | | | x | | | | | x | | x |
| Security System Intruder Alarm Status | | | x | | | | | x | | x |
| Fire Alarm Status | | | x | | | | | x | | x |
| Corridor Lighting 1 Command | | | | x | | | | x | | x |
| Corridor Lighting 2 Command | | | | x | | | | x | | x |
| Corridor Lighting 1 Amps | x | | | | | | | x | | x |
| Corridor Lighting 2 Amps | x | | | | | | | x | | x |

### 3.33 SEQUENCES OF OPERATION FOR LIGHTING - OUTDOOR

**Run Conditions:**
The outdoor lighting shall turn on based upon local sunset times provided the following is true:

- The user definable schedule is set to occupied.
- OR the building alarm system is disarmed.
- OR the building alarm system has been armed for less than 15 minutes.
- OR there is an intruder alarm.
- OR there is a fire alarm.

**Points:**

| BAS Points | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Point Name | Hardware Points | | | | Software Points | | | Trend | Alarm | Show on Graphic |
| | AI | AO | BI | BO | AV | BV | MV | | | |
| Outdoor Air Temperature | | | | | x | | | x | | x |
| Occupied Schedule | | | | | | | x | x | | x |
| Effective Occupancy | | | | | | | x | x | | x |
| Occupancy Override | | | | | | | x | | | x |
| Security System Armed Status | | | | | | | x | x | | x |
| Security System Intruder Alarm Status | | | | | | | x | x | | x |
| Fire Alarm Status | | | | | | | x | x | | x |
| Solar Clock | | | | | | | x | x | | x |
| Outdoor Lighting 1 Command | | | | x | | | | x | | x |
| Outdoor Lighting 2 Command | | | | x | | | | x | | x |
| Outdoor Lighting 1 Amps | x | | | | | | | x | | x |
| Outdoor Lighting 2 Amps | x | | | | | | | x | | x |

### 3.34 SEQUENCES OF OPERATION FOR DOMESTIC HOT WATER SYSTEM

**Run Conditions – Scheduled:**
The domestic hot water recirculation pump shall be turned on or off based on a user definable schedule.

Domestic Hot Water Temperature Monitoring:
The following temperatures shall be monitored.

- Domestic hot water temperature.

**Alarms:**

- Domestic Hot Water Pump Status: Mismatch between the pump command and the pump status for 30 minutes.

**Points:**

| BAS Points | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Point Name | Hardware Points | | | | Software Points | | | Trend | Alarm | Show on Graphic |
| | AI | AO | BI | BO | AV | BV | MV | | | |
| Outdoor Air Temperature | | | | | x | | | x | | x |
| Domestic Hot Water Temperature | x | | | | | | | x | | x |
| Occupied Schedule | | | | | | | x | x | | x |
| Effective Occupancy | | | | | | | x | x | | x |
| Occupancy Override | | | | | | | x | | | x |
| Domestic Hot Water Pump Command | | | | x | | | | x | | x |
| Domestic Hot Water Pump Amps | x | | | | | | | x | | x |
| Domestic Hot Water Pump Status | | | | | | x | | x | x | |

### 3.35 DASHBOARD POINTS LIST

| System | Show on Graphic | Link |
|---|---|---|
| **RTU-1 N-W Addition** | | x |
| RTU-1 Discharge Air Temperature | x | |
| RTU-1 Supply Fan Status | x | |
| RTU-1 Low Temperature Alarm | x | |
| **RTU-2 N-E Addition Exterior Rooms** | | x |
| RTU-2 Discharge Air Temperature | x | |
| RTU-2 Supply Fan Status | x | |
| RTU-2 Low Temperature Alarm | x | |
| **RTU-3 N-E Addition Interior Rooms** | | x |
| RTU-3 Discharge Air Temperature | x | |
| RTU-3 Supply Fan Status | x | |
| RTU-3 Low Temperature Alarm | x | |
| **RTU-4 Learning Commons N-W** | | x |
| RTU-4 Discharge Air Temperature | x | |

| | | |
|---|---|---|
| RTU-4 Supply Fan Status | x | |
| RTU-4 Low Temperature Alarm | x | |
| **RTU-5 Learning Commons S-E** | | x |
| RTU-5 Discharge Air Temperature | x | |
| RTU-5 Supply Fan Status | x | |
| RTU-5 Low Temperature Alarm | x | |
| **RTU-6 Cafeteria - West** | | x |
| RTU-6 Discharge Air Temperature | x | |
| RTU-6 Supply Fan Status | x | |
| RTU-6 Low Temperature Alarm | x | |
| **RTU-7 Wood and Welding Shop** | | x |
| RTU-7 Discharge Air Temperature | x | |
| RTU-7 Supply Fan Status | x | |
| RTU-7 Low Temperature Alarm | x | |
| **RTU-8 Auto Shop** | | x |
| RTU-8 Discharge Air Temperature | x | |
| RTU-8 Supply Fan Status | x | |
| RTU-8 Low Temperature Alarm | x | |
| **AHU-1 Central Classrooms** | | x |
| AHU-1 Discharge Air Temperature | x | |
| AHU-1 Supply Fan Status | x | |
| AHU-1 Low Temperature Alarm | x | |
| **AHU-2 Gym and Stage** | | x |
| AHU-2 Discharge Air Temperature | x | |
| AHU-2 Supply Fan Status | x | |
| AHU-2 Low Temperature Alarm | x | |
| **AHU-3 South Addition** | | x |
| AHU-3 Discharge Air Temperature | x | |
| AHU-3 Supply Fan Status | x | |
| AHU-3 Low Temperature Alarm | x | |
| **AHU-4 Administration** | | x |
| AHU-4 Discharge Air Temperature | x | |

| | | |
|---|---|---|
| AHU-4 Supply Fan Status | x | |
| AHU-4 Low Temperature Alarm | x | |
| **AHU-5 - Cafeteria East and Servery** | | x |
| AHU-5 Discharge Air Temperature | x | |
| AHU-5 Supply Fan Status | x | |
| **MAU-1 Kitchen** | | x |
| MAU-1 Discharge Air Temperature | x | |
| MAU-1 Supply Fan Status | x | |
| **Heating Plant** | | x |
| Hot Water Supply Temperature | x | |
| Hot Water Supply Setpoint | x | |
| Hot Water System Available | x | |
| **Heat Exchangers** | | x |
| HE-1 (Main) Glycol Supply Temperature | x | |
| HE-2 (North) Glycol Supply Temperature | x | |
| HE-3 (South) Glycol Supply Temperature | x | |
| **Energy** | | x |
| Electrical Demand | x | |
| Natural Gas Demand | x | |
| **Exhaust Fans** | | x |
| **Outdoor Lighting** | | x |
| **Corridor Lighting** | | x |
| **Domestic Hot Water** | | x |
| **Calendars** | | x |
| **Floor 1 North** | | x |
| **Floor 1 Central** | | x |
| **Floor 1 South** | | x |
| **Floor 2 Central** | | x |
| **Floor 2 South** | | x |

### 3.35 SCHEDULING AND CALENDARS

Schedules:
The table below shows the scheduled times of all equipment and handling of calendar dates.

Calendars:

All equipment shall run based on a weekly time-of-day schedule. The Schedule shall automatically adjust if either of the Calendars are True:

- **Holiday Calendar:** Defines holidays such as Christmas, Easter, Labor Day, etc., when the building is vacant.
- **Alternate Calendar:** Defines days that students and teachers are away and the building closes early. Typically, during summer and march break when custodians are working.
- **PD Day Calendar:** Defines PD days where students are away but custodians and teachers are present.

Motion Sensor Enable Schedules:
The Motion Sensor Enable Schedules shall be grouped as follows:

- Classroom, Cafeteria and Learning Commons Motion Sensor Enable Schedule
  - AHU-1
  - AHU-3
  - RTU-1
  - RTU-2
  - RTU-3
  - RTU-4
  - RTU-5
- Administration Motion Sensor Enable Schedule
  - AHU-4
- Gym Motion Enable Schedule
  - AHU-2

Motion Sensor Enable Schedules shall be configured in accordance with the tables below. When a calendar becomes active, it shall automatically apply the corresponding Motion Enable Schedule so that it aligns with the times defined in the table

| **RTU-1 N-W Addition** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Monday to Friday** | **Holiday Calendar** | **Alternate Day Calendar** | **PD Day Calendar** | **Occupied** | **Standby** | **Unoccupied** | **Motion Control** |
| FALSE | FALSE | FALSE | FALSE | | | 12am-12am | Disable |
| TRUE | TRUE | FALSE | FALSE | | | 12am-12am | Disable |
| TRUE | FALSE | FALSE | FALSE | 6:55am | | 5pm | 5pm-10pm |
| TRUE | FALSE | FALSE | TRUE | | 6:55am | 5pm | 5pm-10pm |
| TRUE | FALSE | TRUE | FALSE | | | | 6:55am-4pm |
| Air Handler goes into Standby Mode when Motion Control is Enabled and Motion is Detected | | | | | | | |
| **RTU-2 N-E Addition Exterior Rooms** | | | | | | | |
| **Monday to Friday** | **Holiday Calendar** | **Alternate Day Calendar** | **PD Day Calendar** | **Occupied** | **Standby** | **Unoccupied** | **Motion Control** |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| FALSE | FALSE | FALSE | FALSE | | | 12am-12am | Disable |
| TRUE | TRUE | FALSE | FALSE | | | 12am-12am | Disable |
| TRUE | FALSE | FALSE | FALSE | 6:57am | | 5pm | 5pm-10pm |
| TRUE | FALSE | FALSE | TRUE | | 6:57am | 5pm | 5pm-10pm |
| TRUE | FALSE | TRUE | FALSE | | | | 6:57am-4pm |
| Air Handler goes into Standby Mode when Motion Control is Enabled and Motion is Detected | | | | | | | |
| **RTU-3 N-E Addition Interior Rooms** | | | | | | | |
| **Monday to Friday** | **Holiday Calendar** | **Alternate Day Calendar** | **PD Day Calendar** | **Occupied** | **Standby** | **Unoccupied** | **Motion Control** |
| FALSE | FALSE | FALSE | FALSE | | | 12am-12am | Disable |
| TRUE | TRUE | FALSE | FALSE | | | 12am-12am | Disable |
| TRUE | FALSE | FALSE | FALSE | 6:59am | | 5pm | 5pm-10pm |
| TRUE | FALSE | FALSE | TRUE | | 6:59am | 5pm | 5pm-10pm |
| TRUE | FALSE | TRUE | FALSE | | | | 6:59am-4pm |
| Air Handler goes into Standby Mode when Motion Control is Enabled and Motion is Detected | | | | | | | |
| **RTU-4 Learning Commons N-W** | | | | | | | |
| **Monday to Friday** | **Holiday Calendar** | **Alternate Day Calendar** | **PD Day Calendar** | **Occupied** | **Standby** | **Unoccupied** | **Motion Control** |
| FALSE | FALSE | FALSE | FALSE | | | 12am-12am | Disable |
| TRUE | TRUE | FALSE | FALSE | | | 12am-12am | Disable |
| TRUE | FALSE | FALSE | FALSE | 7:15am | | 4pm | 4pm-10pm |
| TRUE | FALSE | FALSE | TRUE | | 7:15am | 4pm | 4pm-10pm |
| TRUE | FALSE | TRUE | FALSE | | | | 7:15am-4pm |
| Air Handler goes into Standby Mode when Motion Control is Enabled and Motion is Detected | | | | | | | |
| **RTU-5 Learning Commons S-E** | | | | | | | |
| **Monday to Friday** | **Holiday Calendar** | **Alternate Day Calendar** | **PD Day Calendar** | **Occupied** | **Standby** | **Unoccupied** | **Motion Control** |
| FALSE | FALSE | FALSE | FALSE | | | 12am-12am | Disable |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| TRUE | TRUE | FALSE | FALSE | | | 12am-12am | Disable |
| TRUE | FALSE | FALSE | FALSE | 7:16am | | 4pm | 4pm-10pm |
| TRUE | FALSE | FALSE | TRUE | | 7:16am | 4pm | 4pm-10pm |
| TRUE | FALSE | TRUE | FALSE | | | | 7:16am-4pm |
| Air Handler goes into Standby Mode when Motion Control is Enabled and Motion is Detected | | | | | | | |
| **RTU-6 Cafeteria - West** | | | | | | | |
| **Monday to Friday** | **Holiday Calendar** | **Alternate Day Calendar** | **PD Day Calendar** | **Occupied** | **Standby** | **Unoccupied** | **Motion Control** |
| FALSE | FALSE | FALSE | FALSE | | | 12am-12am | Disable |
| TRUE | TRUE | FALSE | FALSE | | | 12am-12am | Disable |
| TRUE | FALSE | FALSE | FALSE | 7:10am | | 4pm | 4pm-10pm |
| TRUE | FALSE | FALSE | TRUE | | 7:10am | 4pm | 4pm-10pm |
| TRUE | FALSE | TRUE | FALSE | | | | 7:10am-4pm |
| Air Handler goes into Occupied Mode when Motion Control is Enabled and Motion is Detected | | | | | | | |
| **RTU-7 Woodworking Shop** | | | | | | | |
| **Monday to Friday** | **Holiday Calendar** | **Alternate Day Calendar** | **PD Day Calendar** | **Occupied** | **Standby** | **Unoccupied** | **Motion Control** |
| FALSE | FALSE | FALSE | FALSE | | | 12am-12am | N/A |
| TRUE | TRUE | FALSE | FALSE | | | 12am-12am | N/A |
| TRUE | FALSE | FALSE | FALSE | 8:00am | | 4pm | N/A |
| TRUE | FALSE | FALSE | TRUE | | 8:00am | 4pm | N/A |
| TRUE | FALSE | TRUE | FALSE | | | 12am-12am | N/A |
| **RTU-8 Auto Shop** | | | | | | | |
| **Monday to Friday** | **Holiday Calendar** | **Alternate Day Calendar** | **PD Day Calendar** | **Occupied** | **Standby** | **Unoccupied** | **Motion Control** |
| FALSE | FALSE | FALSE | FALSE | | | 12am-12am | N/A |
| TRUE | TRUE | FALSE | FALSE | | | 12am-12am | N/A |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| TRUE | FALSE | FALSE | FALSE | 8:05am | | 4pm | N/A |
| TRUE | FALSE | FALSE | TRUE | | 8:05am | 4pm | N/A |
| TRUE | FALSE | TRUE | FALSE | | | 12am-12am | N/A |

**AHU-1 Central Classrooms**

| Monday to Friday | Holiday Calendar | Alternate Day Calendar | PD Day Calendar | Occupied | Standby | Unoccupied | Motion Control |
|---|---|---|---|---|---|---|---|
| FALSE | FALSE | FALSE | FALSE | | | 12am-12am | Disable |
| TRUE | TRUE | FALSE | FALSE | | | 12am-12am | Disable |
| TRUE | FALSE | FALSE | FALSE | 7:01am | | 5pm | 5pm-10pm |
| TRUE | FALSE | FALSE | TRUE | | 7:01am | 5pm | 5pm-10pm |
| TRUE | FALSE | TRUE | FALSE | | | | 7:01am-4pm |

Air Handler goes into Standby Mode when Motion Control is Enabled and Motion is Detected

**AHU-2 Gym and Stage**

| Monday to Friday | Holiday Calendar | Alternate Day Calendar | PD Day Calendar | Occupied | Standby | Unoccupied | Motion Control |
|---|---|---|---|---|---|---|---|
| FALSE | FALSE | FALSE | FALSE | | | | 7am-10pm |
| TRUE | TRUE | FALSE | FALSE | | | 12am-12am | Disable |
| TRUE | FALSE | FALSE | FALSE | 7:05am | | 5pm | 5pm-10pm |
| TRUE | FALSE | FALSE | TRUE | | 7:05am | 5pm | 5pm-10pm |
| TRUE | FALSE | TRUE | FALSE | | | | 7:05am-4pm |

Air Handler goes into Occupied Mode when Motion Control is Enabled and Motion is Detected

**AHU-3 South Addition**

| Monday to Friday | Holiday Calendar | Alternate Day Calendar | PD Day Calendar | Occupied | Standby | Unoccupied | Motion Control |
|---|---|---|---|---|---|---|---|
| FALSE | FALSE | FALSE | FALSE | | | 12am-12am | Off |
| TRUE | TRUE | FALSE | FALSE | | | 12am-12am | Off |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| TRUE | FALSE | FALSE | FALSE | 7:03am | | 5pm | 5pm-10pm |
| TRUE | FALSE | FALSE | TRUE | | 7:03am | 5pm | 5pm-10pm |
| TRUE | FALSE | TRUE | FALSE | | | | 7:03am-4pm |
| Air Handler goes into Standby Mode when Motion Control is Enabled and Motion is Detected | | | | | | | |

**AHU-4 Administration**

| Monday to Friday | Holiday Calendar | Alternate Day Calendar | PD Day Calendar | Occupied | Standby | Unoccupied | Motion Control |
|---|---|---|---|---|---|---|---|
| FALSE | FALSE | FALSE | FALSE | | | 12am-12am | Disable |
| TRUE | TRUE | FALSE | FALSE | | | 12am-12am | Disable |
| TRUE | FALSE | FALSE | FALSE | 7:00am | | 5pm | Disable |
| TRUE | FALSE | FALSE | TRUE | | 7:00am | 5pm | Disable |
| TRUE | FALSE | TRUE | FALSE | | | | 7:00am-4pm |
| Air Handler goes into Standby Mode when Motion Control is Enabled and Motion is Detected | | | | | | | |

**AHU-5 - Cafeteria East and Servery**

| Monday to Friday | Holiday Calendar | Alternate Day Calendar | PD Day Calendar | Occupied | Standby | Unoccupied | Motion Control |
|---|---|---|---|---|---|---|---|
| FALSE | FALSE | FALSE | FALSE | | | 12am-12am | Disable |
| TRUE | TRUE | FALSE | FALSE | | | 12am-12am | Disable |
| TRUE | FALSE | FALSE | FALSE | 7:15am | | 4pm | 4pm-10pm |
| TRUE | FALSE | FALSE | TRUE | | 7:15am | 4pm | 4pm-10pm |
| TRUE | FALSE | TRUE | FALSE | | | | 7:15am-4pm |
| Air Handler goes into Occupied Mode when Motion Control is Enabled and Motion is Detected | | | | | | | |

**MAU-1 Kitchen**

| Monday to Friday | Holiday Calendar | Alternate Day Calendar | PD Day Calendar | Occupied | Standby | Unoccupied | Motion Control |
|---|---|---|---|---|---|---|---|
| FALSE | FALSE | FALSE | FALSE | | | 12am-12am | N/A |
| TRUE | TRUE | FALSE | FALSE | | | 12am-12am | N/A |
| TRUE | FALSE | FALSE | FALSE | 6:00am | | 5pm | N/A |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| TRUE | FALSE | FALSE | TRUE | 6:00am | | 5pm | N/A |
| TRUE | FALSE | TRUE | FALSE | | | 12am-12am | N/A |
| **Exhaust Fans** | | | | | | | |
| **Monday to Friday** | **Holiday Calendar** | **Alternate Day Calendar** | **PD Day Calendar** | **Occupied** | **Standby** | **Unoccupied** | **Motion Control** |
| FALSE | FALSE | FALSE | FALSE | | | 12am-12am | N/A |
| TRUE | TRUE | FALSE | FALSE | | | 12am-12am | N/A |
| TRUE | FALSE | FALSE | FALSE | 6:30am | | 9pm | N/A |
| TRUE | FALSE | FALSE | TRUE | 6:30am | | 9pm | N/A |
| TRUE | FALSE | TRUE | FALSE | 6:30am | | 3:30pm | N/A |
| **Outdoor Lighting** | | | | | | | |
| **Monday to Friday** | **Holiday Calendar** | **Alternate Day Calendar** | **PD Day Calendar** | **Occupied** | **Standby** | **Unoccupied** | **Motion Control** |
| FALSE | FALSE | FALSE | FALSE | | | 12am-12am | N/A |
| TRUE | TRUE | FALSE | FALSE | | | 12am-12am | N/A |
| TRUE | FALSE | FALSE | FALSE | 6:00am | | 8:00am | N/A |
| TRUE | FALSE | FALSE | TRUE | 6:00am | | 8:00am | N/A |
| TRUE | FALSE | TRUE | FALSE | 6:00am | | 8:00am | N/A |
| See Outdoor Lighting Sequence of Operations for further information | | | | | | | |
| **Domestic Hot Water** | | | | | | | |
| **Monday to Friday** | **Holiday Calendar** | **Alternate Day Calendar** | **PD Day Calendar** | **Occupied** | **Standby** | **Unoccupied** | **Motion Control** |
| FALSE | FALSE | FALSE | FALSE | | | 12am-12am | N/A |
| TRUE | TRUE | FALSE | FALSE | | | 12am-12am | N/A |
| TRUE | FALSE | FALSE | FALSE | 6:30am | | 5pm | N/A |
| TRUE | FALSE | FALSE | TRUE | 6:30am | | 5pm | N/A |
| TRUE | FALSE | TRUE | FALSE | 6:30am | | 3:30pm | N/A |

### 3.36 ADJUSTING

.1 Modify sequences of operation to improve system stability and equipment protection, as requested by the Consultant.

**END OF SECTION**

**APPENDIX A – EXISTING SYSTEMS**

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Dashboard

Johnson Controls

## Outside Air

Outside Air Temperature
???? ????

## Building Navigation


2nd Floor


1st Floor

## Secondary Systems

Domestic Hot Water

Servery Make Up Air Unit

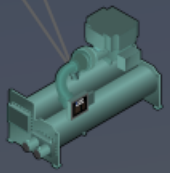
## NAE Status

Critical Alarms
?? ?? ??

## Primary Systems

Chilled Water Supply Temperatrue
???? ????

Chiller Status/Enable
???? ???? ???? ????


Chilled Water System

Hot Water Return Temperature
???? ????

HWSYS Available
???? ????

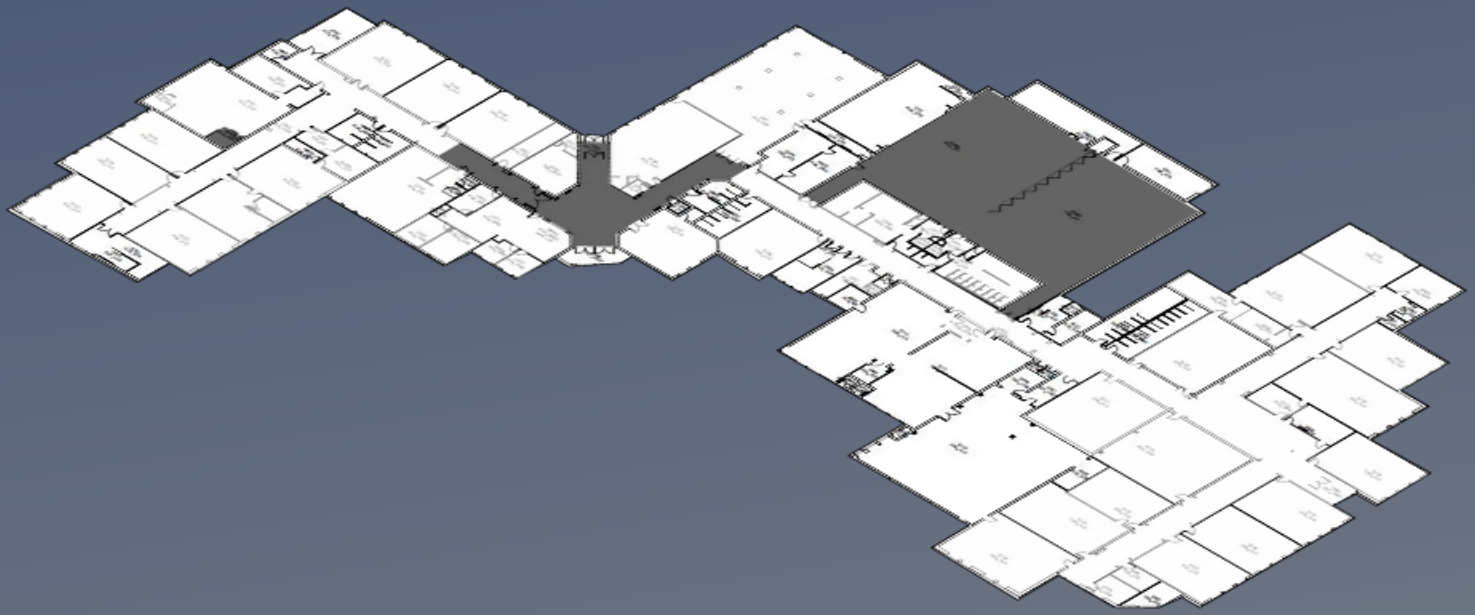

Heating Plant

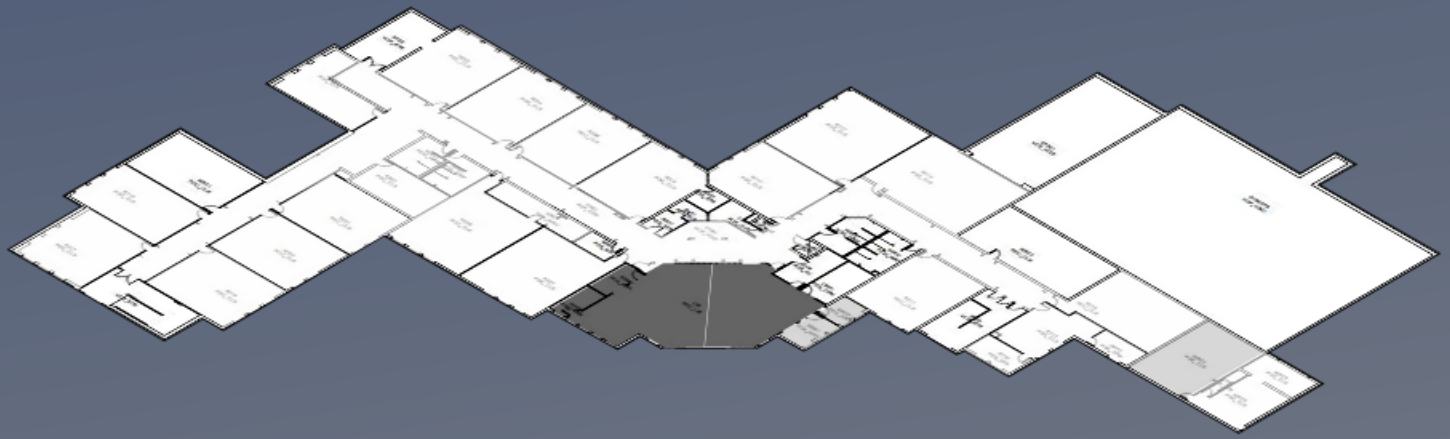
| | | | |
|---|---|---|---|
| AHU-1 | Supply Air Temperature ???? ???? | Classrooms and Changerooms |
| AHU-2 | Supply Air Temperature ???? ???? | Gymnasium |
| AHU-3 | Supply Air Temperature ???? ???? | South Addition Classrooms |
| AHU-4 | Supply Air Temperature ???? ???? | Administration |
| RTU-1 | Supply Air Temperature ???? ???? | North Addition - West Classrooms |
| RTU-2 | Supply Air Temperature ???? ???? | North Addition - North East Classrooms |
| RTU-3 | Supply Air Temperature ???? ???? | North Addition - South East Classrooms |
| RTU-5 | Zone Temperature ???? ???? | Cafeteria West |
| FCU-1 | Zone Temperature ???? ???? | Cafeteria East and Servery |
| RTU-7 | Supply Air Temperature ???? ???? | Careers Room |
| RTU-8 | Supply Air Temperature ???? ???? | Library |

Denis O`Conner - DCDSB

1st Floor

HOME | HEATING PLANT | COOLING PLANT | 2ND FLOOR





# Reheat Coil

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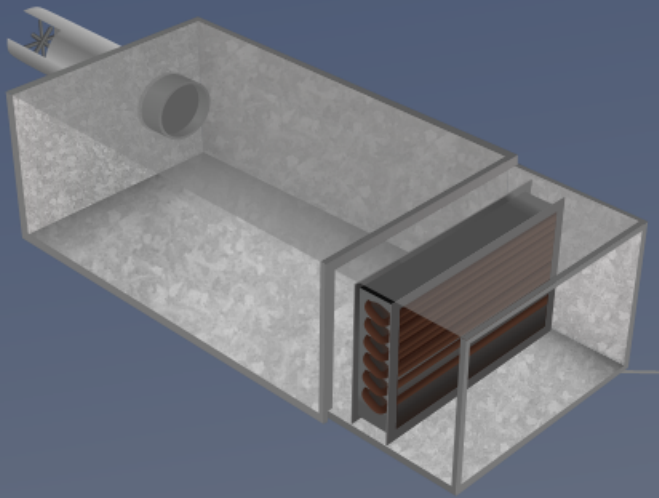
HOME | 1ST FLOOR | 2ND FLOOR

Johnson Controls

97%

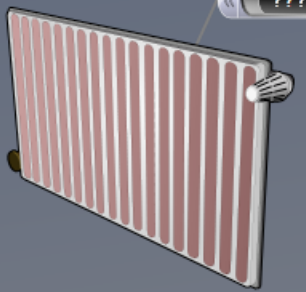
## Setpoints/Biases

| | |
|---|---|
| Occupied Heating Setpoint | ???? ???? |
| Unoccupied Heating Setpoint | ???? ???? |



Reheat Valve ???? ????

Radiator ???? ????



Zone Temperature ???? ????

Setpoint Adjusted By: ???? ????

Actual Heating Setpoint ???? ????

Occupancy Status ???? ????

Outdoor Air Temp ???? ????

# Reheat Coil

Archbishop Dennis O`Conner - DCDSB

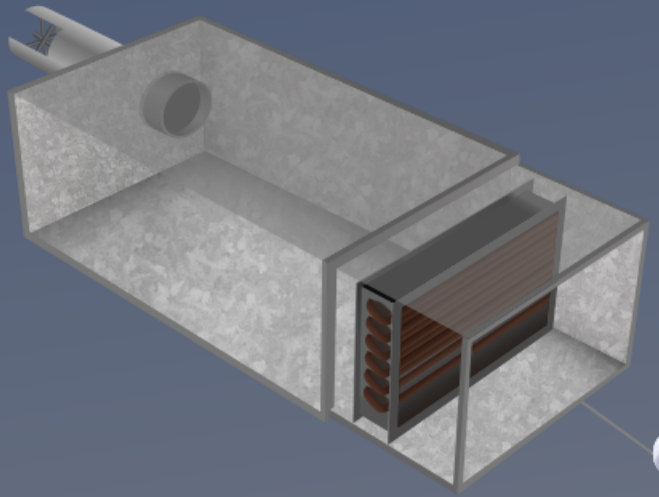
Johnson Controls



97%

## Setpoints/Biases

| | |
|---|---|
| Occupied Heating Setpoint | ???? ???? |
| Unoccupied Heating Setpoint | ???? ???? |



Reheat Valve

???? ????

Outdoor Air Temp

???? ????

Zone Temperature

???? ????

Setpoint Adjusted By:

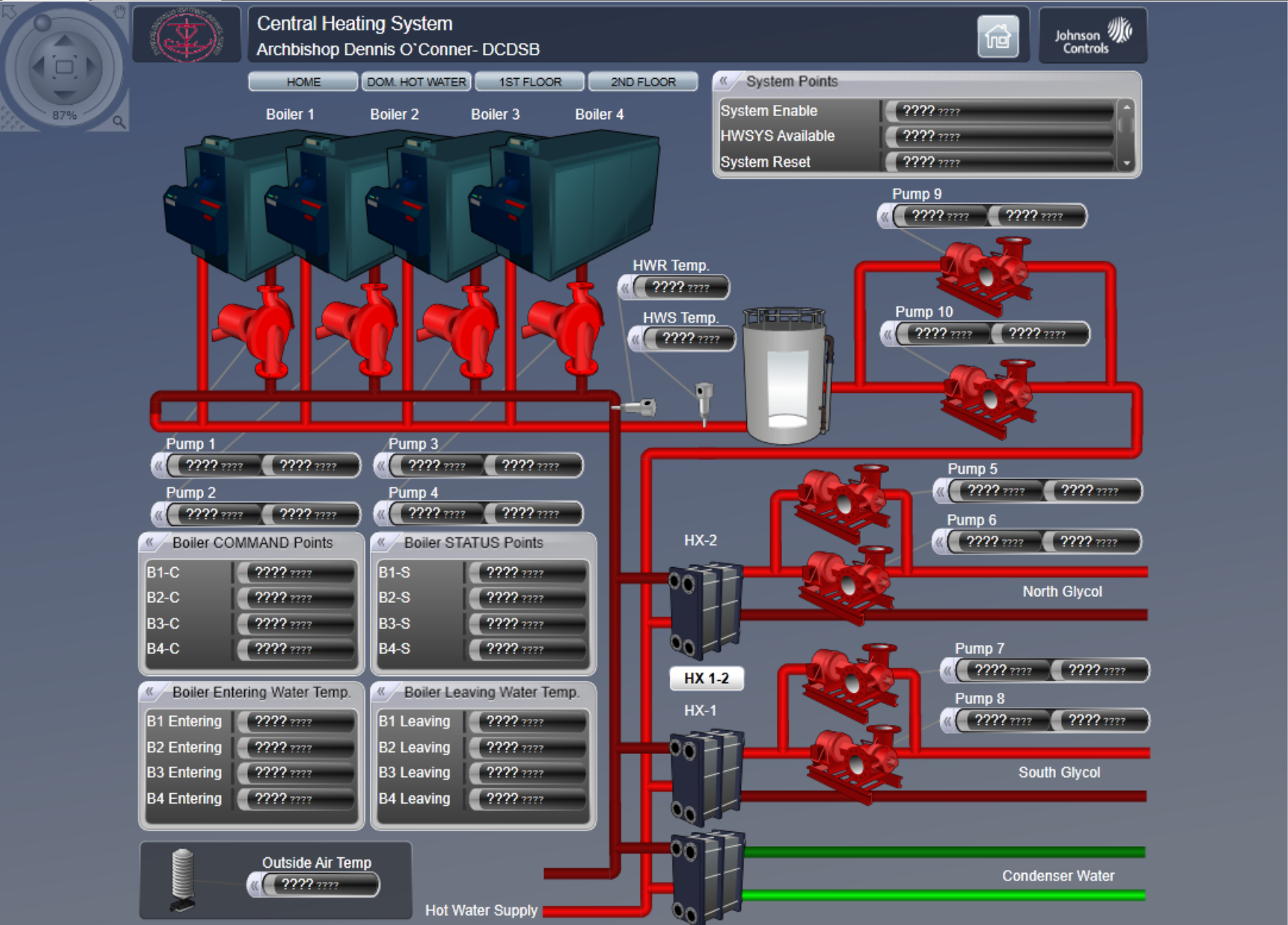
???? ????

Actual Heating Setpoint

???? ????

Occupancy Status

???? ????


Central Heating System
Archbishop Dennis O`Conner- DCDSB
Johnson Controls
HOME
DOM. HOT WATER
1ST FLOOR
2ND FLOOR
Boiler 1
Boiler 2
Boiler 3
Boiler 4
System Points
System Enable
HWSYS Available
System Reset
Pump 9
Pump 10
HWR Temp.
HWS Temp.
Pump 1
Pump 2
Pump 3
Pump 4
Pump 5
Pump 6
Pump 7
Pump 8
HX-2
HX 1-2
HX-1
North Glycol
South Glycol
Condenser Water
Hot Water Supply
Boiler COMMAND Points
B1-C
B2-C
B3-C
B4-C
Boiler STATUS Points
B1-S
B2-S
B3-S
B4-S
Boiler Entering Water Temp.
B1 Entering
B2 Entering
B3 Entering
B4 Entering
Boiler Leaving Water Temp.
B1 Leaving
B2 Leaving
B3 Leaving
B4 Leaving
Outside Air Temp

# Chilled Water System

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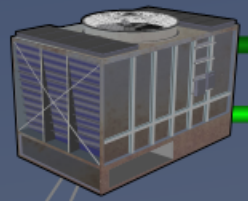
Johnson Controls

HOME | 1ST FLOOR | 2ND FLOOR | CHILLER SCHEDULE

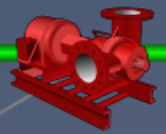


Cooling Tower ???? ???? ???? ????

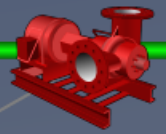
Fan Speed ???? ????

CNDR Temp. ???? ???? ???? ????

HE-4

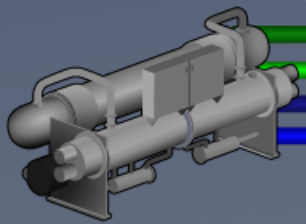


Condenser Pump 14 ???? ???? ???? ????



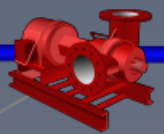
Condenser Pump 15 ???? ???? ???? ????

CNDS Temp. ???? ????

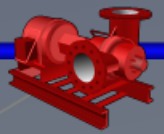


CHWR Temp. ???? ????

CHWS Temp. ???? ????



Chilled Water Pump 12 ???? ???? ???? ????



Chilled Water Pump 13 ???? ???? ???? ????

**Chiller Points**

| | |
|---|---|
| Command | ???? ???? |
| Status | ???? ???? |

Outdoor Air Temp ???? ????

**System Points**

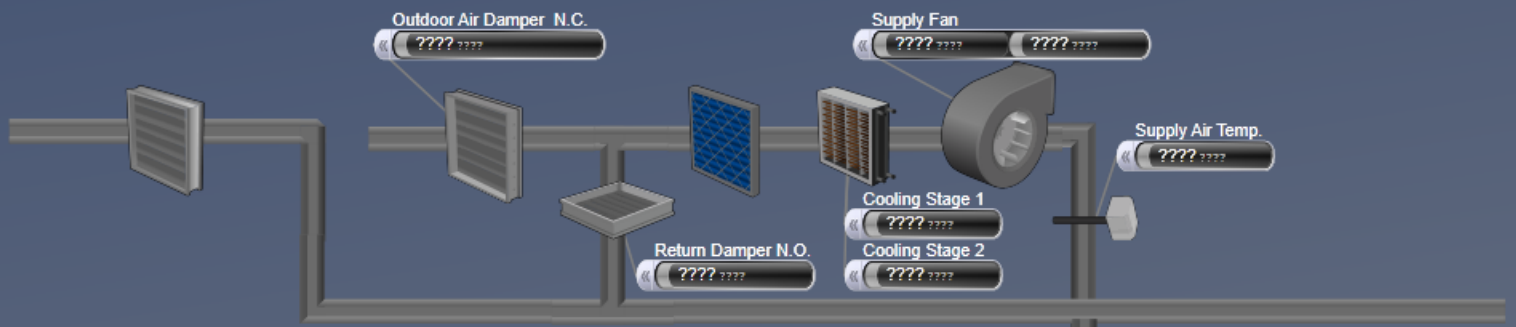
| | |
|---|---|
| Season | ???? ???? |
| CHWSYS Available | ???? ???? |
| AHUs Req. Cooling | ???? ???? |
| Pump 12 is | ???? ???? |
| Pump 14 is | ???? ???? |

# Roof Top Unit 5 - Cafeteria

Archbishop Dennis O'Conner - DCDSB

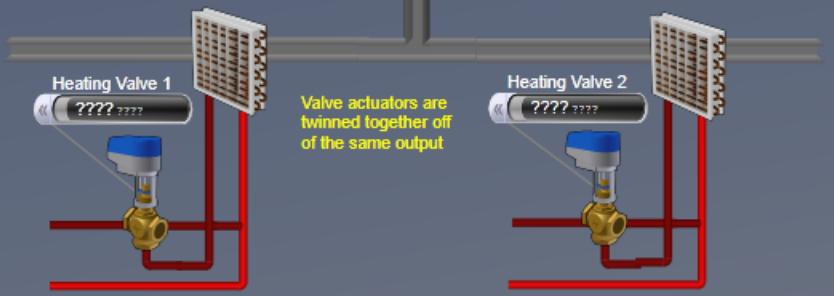
Johnson Controls

HOME | HEATING PLANT | CHILLER PLANT | 1ST FLOOR | 2ND FLOOR | RTU-3 | FCU-1 | RTU-5 SCHEDULE




**Setpoints/Biases**

| | |
|---|---|
| Occupied Heating Setpoint | ???? ???? |
| Occupied Cooling Setpoint | ???? ???? |
| Unoccupied Heating Setpoint | ???? ???? |
| Unoccupied Cooling Setpoint | ???? ???? |




Outdoor Air Temp

???? ????

Zone Temperature

???? ????

Setpoint Adjusted By:

???? ????

Actual Heating Setpoint

???? ????

Actual Cooling Setpoint

???? ????

Effective Occupancy

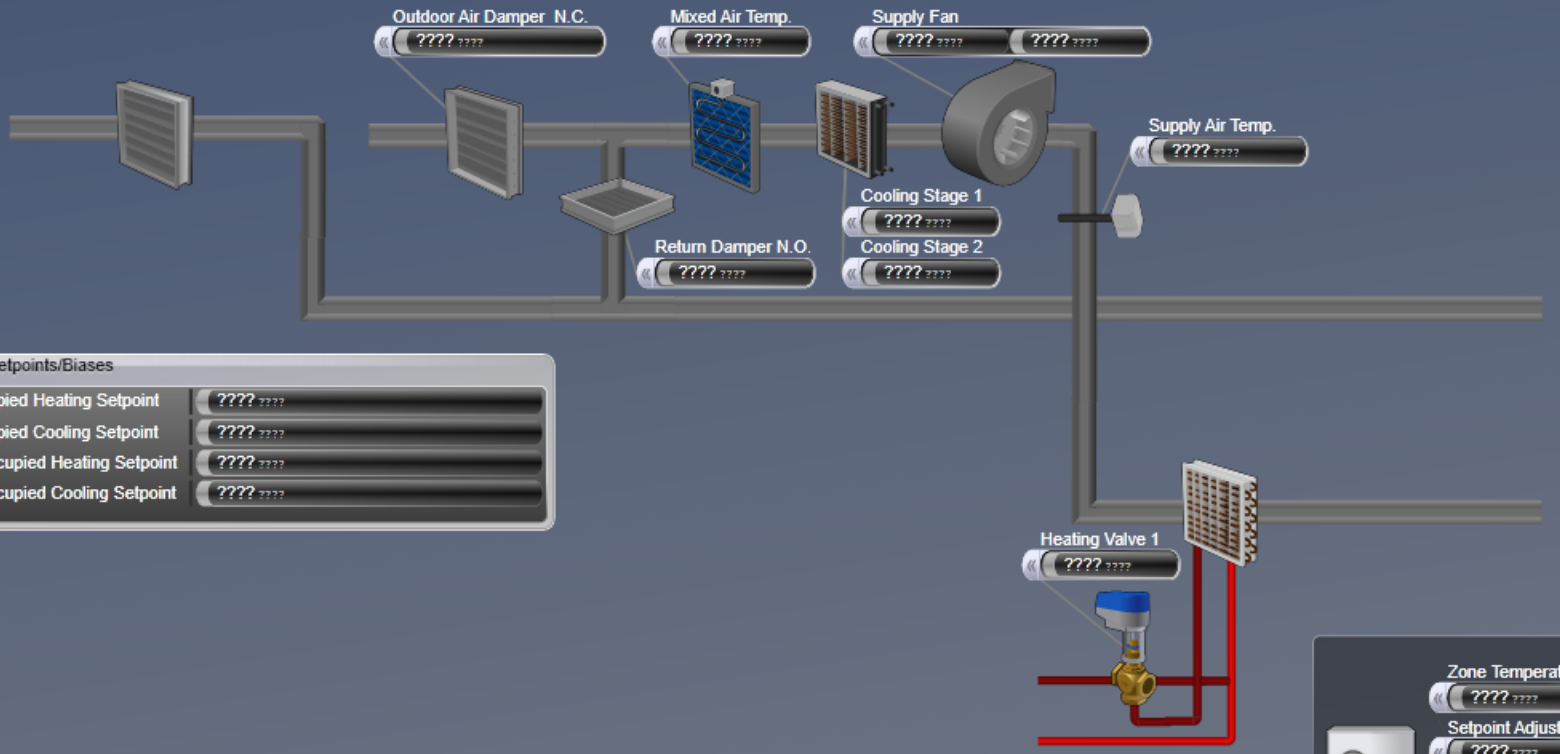
???? ????

# Roof Top Unit 7 - Careers Room

Archbishop Dennis O'Conner - DCDSB

Johnson Controls

HOME | HEATING PLANT | CHILLER PLANT | 1ST FLOOR | 2ND FLOOR | FCU-1 | RTU-8 | RTU-7 SCHEDULE




## Setpoints/Biases

| | |
|---|---|
| Occupied Heating Setpoint | ???? ???? |
| Occupied Cooling Setpoint | ???? ???? |
| Unoccupied Heating Setpoint | ???? ???? |
| Unoccupied Cooling Setpoint | ???? ???? |

Outdoor Air Temp
???? ????

Zone Temperature
???? ????

Setpoint Adjusted By:
???? ????

Actual Heating Setpoint
???? ????

Actual Cooling Setpoint
???? ????

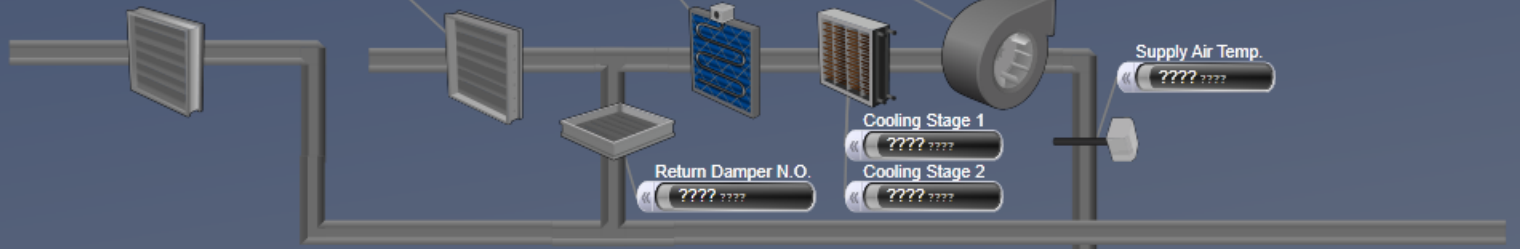
Effective Occupancy
???? ????

# Roof Top Unit 8 - Library

Archbishop Dennis O'Conner - DCDSB

Johnson Controls

HOME | HEATING PLANT | CHILLER PLANT | 1ST FLOOR | 2ND FLOOR | AHU-1 | RTU-7 | RTU-8 SCHEDULE

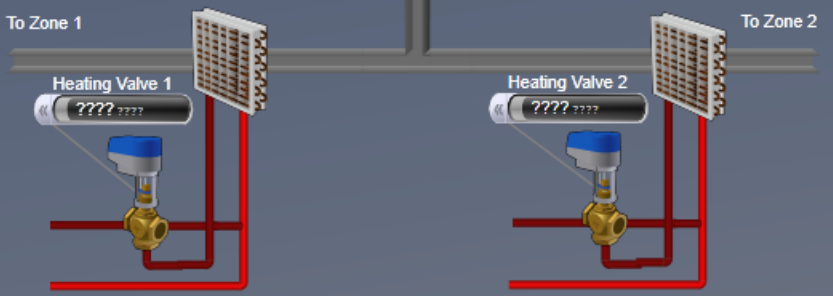



**Setpoints/Biases - Zone 1**

| | |
|---|---|
| Occupied Heating Setpoint | ???? ???? |
| Occupied Cooling Setpoint | ???? ???? |
| Unoccupied Heating Setpoint | ???? ???? |
| Unoccupied Cooling Setpoint | ???? ???? |

**Setpoints/Biases - Zone 2**

| | |
|---|---|
| Occupied Heating Setpoint | ???? ???? |
| Unoccupied Heating Setpoint | ???? ???? |




Outdoor Air Temp
???? ????

Zone 2

Zone Temperature
???? ????

Actual Heating Setpoint
???? ????

Effective Occupancy
???? ????

Zone 1

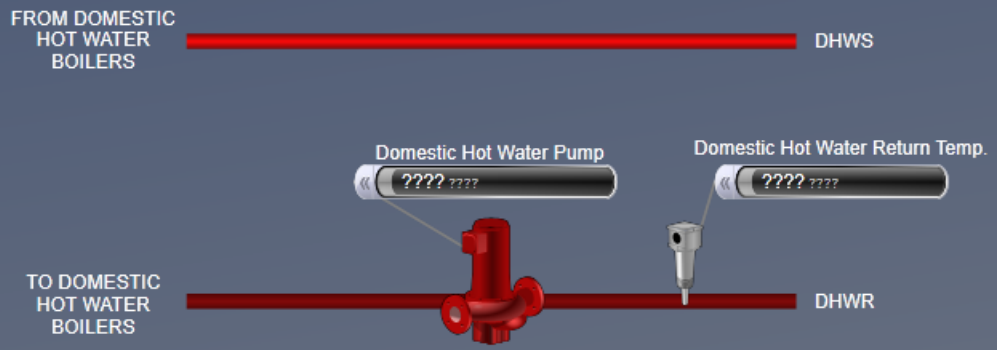
Zone Temperature
???? ????

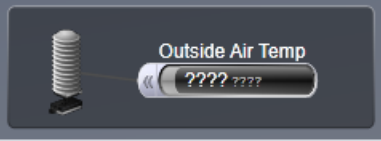
Setpoint Adjusted By:
???? ????

Actual Heating Setpoint
???? ????

Actual Cooling Setpoint
???? ????

Effective Occupancy
???? ????


FROM DOMESTIC HOT WATER BOILERS
DHWS
Domestic Hot Water Pump
???? ????
Domestic Hot Water Return Temp.
???? ????
TO DOMESTIC HOT WATER BOILERS
DHWR


Outside Air Temp
???? ????

System Configuration Tool

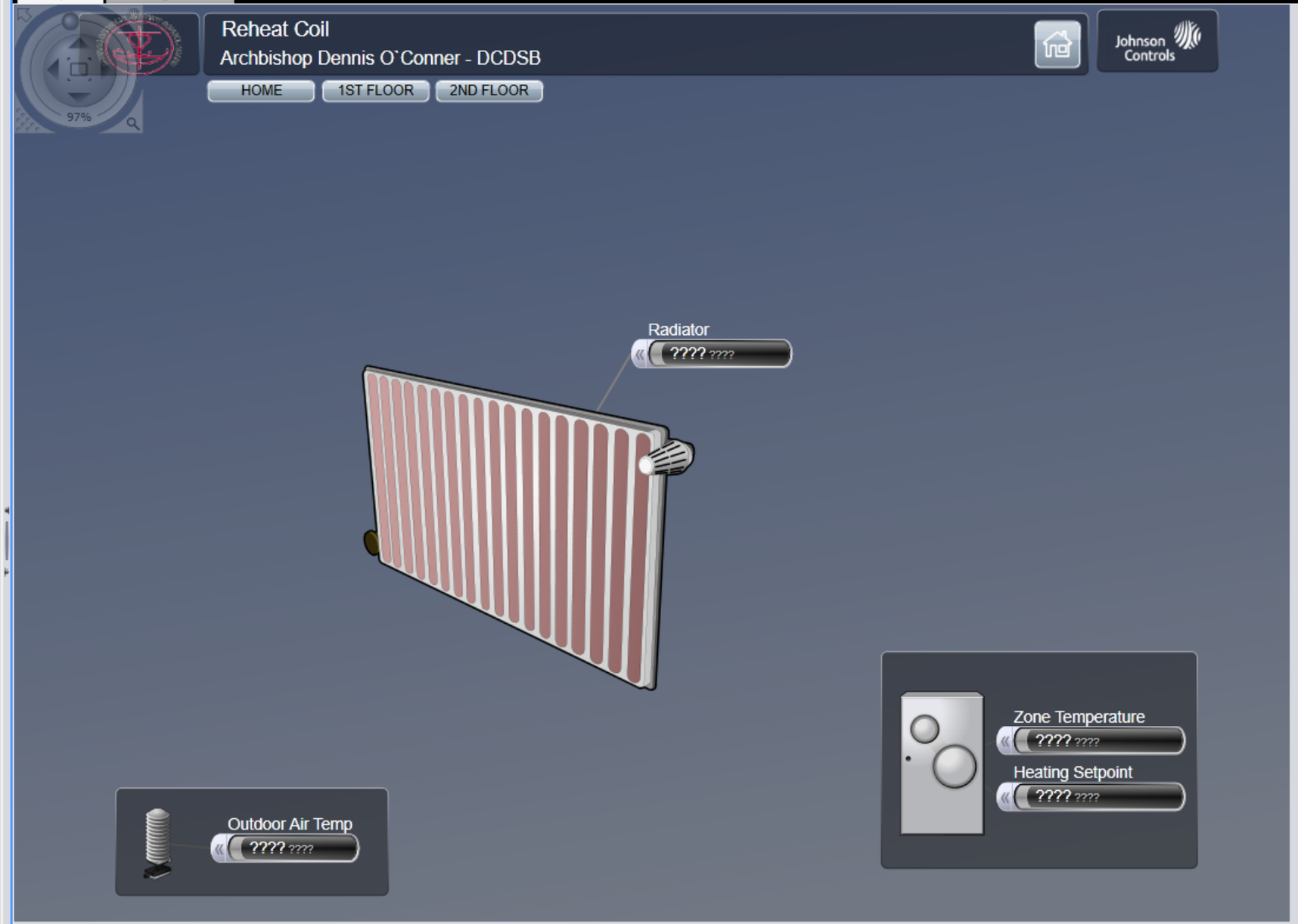
Item Edit View Action Insert Tools Facility Query Try New Version Help

All Items | Equipment | Spaces

- DCDSBOldKS
  - Configuration Data
  - DCDSB-ADX
    - A-ADX2016-WFE (11.0)
      - Facility Graphics
      - Equipment Definitions
      - Graphics - All Saints
      - Graphics - Archbishop Dennis O`Conner
        - Dashboard
        - 1st Floor
        - 2nd Floor
        - AHU-3
        - RH with PH
        - RH
        - Exhaust Fans
        - AHU-1
        - AHU-2
        - AHU-4
        - RTU-1
        - RTU-2
        - RTU-3
        - Heating Plant
        - Chilled Water System
        - RTU-5
        - RTU-7
        - RTU-8
        - Domestic Hot Water
        - CORRIDOR RH
        - Girls Washroom
        - Boys Washroom
        - FCU-1
        - MAU
        - Library North East Office

Girls Washroom

Graphic | Configuration



System Configuration Tool

Item Edit View Action Insert Tools Facility Query Try New Version Help

All Items | Equipment | Spaces

- DCDSBOldKS
  - Configuration Data
  - DCDSB-ADX
    - A-ADX2016-WFE (11.0)
      - Facility Graphics
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        - Dashboard
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        - AHU-3
        - RH with PH
        - RH
        - Exhaust Fans
        - AHU-1
        - AHU-2
        - AHU-4
        - RTU-1
        - RTU-2
        - RTU-3
        - Heating Plant
        - Chilled Water System
        - RTU-5
        - RTU-7
        - RTU-8
        - Domestic Hot Water
        - CORRIDOR RH
        - Girls Washroom
        - Boys Washroom
        - FCU-1
        - MAU
        - Library North East Office

Boys Washroom

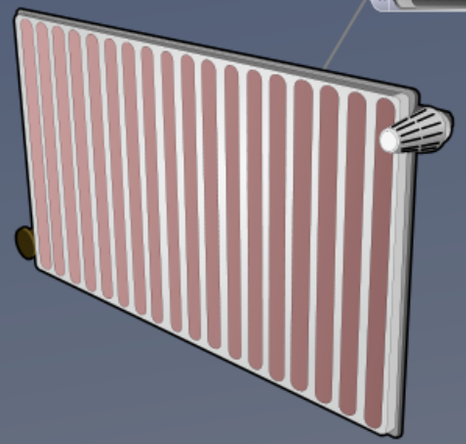
Graphic | Configuration

Reheat Coil

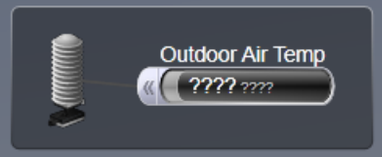
Archbishop Dennis O`Conner - DCDSB

HOME | 1ST FLOOR | 2ND FLOOR

Johnson Controls







System Configuration Tool

Item Edit View Action Insert Tools Facility Query Try New Version Help

All Items | Equipment | Spaces

- DCDSBOldKS
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    - A-ADX2016-WFE (11.0)
      - Facility Graphics
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        - Dashboard
        - 1st Floor
        - 2nd Floor
        - AHU-3
        - RH with PH
        - RH
        - Exhaust Fans
        - AHU-1
        - AHU-2
        - AHU-4
        - RTU-1
        - RTU-2
        - RTU-3
        - Heating Plant
        - Chilled Water System
        - RTU-5
        - RTU-7
        - RTU-8
        - Domestic Hot Water
        - CORRIDOR RH
        - Girls Washroom
        - Boys Washroom
        - FCU-1
        - MAU
        - Library North East Office

FCU-1

Graphic | Configuration

Fan Coil Unit - East Cafeteria

Archbishop Dennis O`Conner - DCDSB

Johnson Controls

HOME | HEATING PLANT | CHILLER PLANT | 1ST FLOOR | 2ND FLOOR | RTU-5 | RTU-7 | FCU-1 SCHEDULE

Outside Air Damper N.C. ???? ????

Supply Fan ???? ???? ???? ????

Fresh Air is from AHU-1

Return Damper N.O. ???? ????

Cooling Stage 1 ???? ????

Cooling Stage 2 ???? ????

Heating Valve ???? ????

Setpoints/Biases

| | |
|---|---|
| Occupied Heating Setpoint | ???? ???? |
| Occupied Cooling Setpoint | ???? ???? |
| Unoccupied Heating Setpoint | ???? ???? |
| Unoccupied Cooling Setpoint | ???? ???? |

Outdoor Air Temp ???? ????

Zone Temperature ???? ????

Setpoint Adjusted By: ???? ????

Actual Heating Setpoint ???? ????

Actual Cooling Setpoint ???? ????

Effective Occupancy ???? ????

System Configuration Tool

Item Edit View Action Insert Tools Facility Query Try New Version Help

All Items | Equipment | Spaces

- DCDSBOldKS
  - Configuration Data
  - DCDSB-ADX
    - A-ADX2016-WFE (11.0)
      - Facility Graphics
      - Equipment Definitions
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      - Graphics - Archbishop Dennis O`Conner
        - Dashboard
        - 1st Floor
        - 2nd Floor
        - AHU-3
        - RH with PH
        - RH
        - Exhaust Fans
        - AHU-1
        - AHU-2
        - AHU-4
        - RTU-1
        - RTU-2
        - RTU-3
        - Heating Plant
        - Chilled Water System
        - RTU-5
        - RTU-7
        - RTU-8
        - Domestic Hot Water
        - CORRIDOR RH
        - Girls Washroom
        - Boys Washroom
        - FCU-1
        - MAU
        - Library North East Office

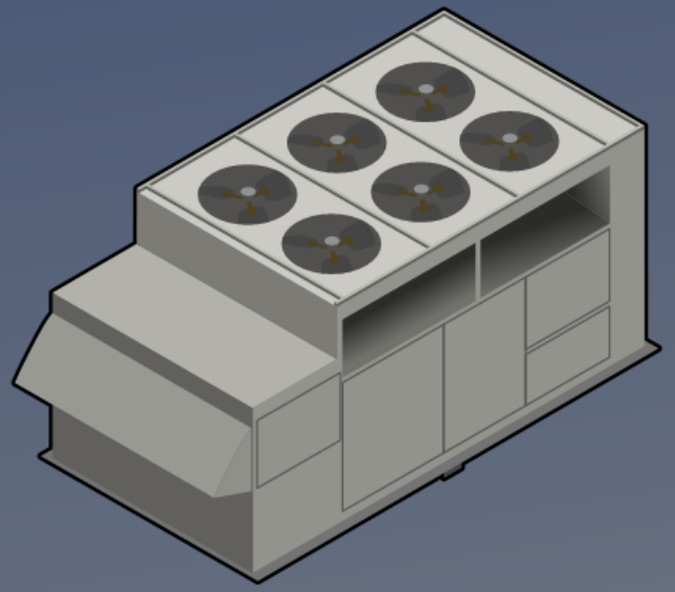
MAU

Graphic | Configuration

Make-Up Air Unit - Servery

Archbishop Dennis O`Conner - DCDSB

HOME | HEATING PLANT | CHILLER PLANT | 1ST FLOOR | 2ND FLOOR | MAU SCHEDULE



Heating is Controlled by the Unit's Onboard Controls

Outdoor Air Temp ???? ????

Zone Temperature ???? ????

Unit Enable ???? ????

**APPENDIX B – POINTS TABLES**

| MECHANICAL EQUIPMENT AND CONTROLLER SUMMARY | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Equipment Tag** | **Location** | **Serving** | **Existing Controller** | **Table** | **Associated** | **Remarks** | **Keynotes** |
| AHU-1 | EB-229 (MEC3) Mechanical Room | Central Classroom | DX-1-01 | AHU-1 | HE-1 | Glycol Heating, DX Cooling, Energy Recovery | |
| AHU-2 | EB-229 (MEC3) Mechanical Room | Gym | DX-1-02 | AHU-2 | HE-1 | Glycol Heating, DX Cooling, Energy Recovery | |
| AHU-3 | EB-205 (MEC1) Mechanical Room | South Classroom Addition | DX-1-20 | AHU-3 | HE-3 | Glycol Heating, DX Cooling, | |
| AHU-4 | EB-214 (MEC2) Mechanical Room | Administration | DX-1-14 | AHU-4 | HE-1 | Glycol Heating, Heat Pump | |
| AHU-5 | EB-127 (CAFS) Servery Ceiling | EB-123 (CAF) /EB-127 (CAFS) Cafeteria East/Servery | UNT-1-16 | AHU-5 | HE-1 | Glycol Heating, DX Cooling. (Fan Coil Unit) | |
| DHW | EB-235A (MEC4) Boiler Room | Entire Building | FEC-03 | DHW | N/A | Domestic Hot Water System | |
| HE-1 | EB-235A (MEC4) Boiler Room | Central Building | FEC-03 | HE-1 | HWS | Heat Exchanger, Glycol Pumps 7&8 | |
| HE-2 | EB-235A (MEC4) Boiler Room | North Classroom Addition | FEC-03 | HE-2 | HWS | Heat Exhanger, Glycol Pumps 5&6 | |
| HE-3 | EB-205 (MEC1) Mechanical Room | South Classroom Addition | DX-20 | HE-3 | HWS | Heat Exhanget, Glycol Pump 10 | |
| HEATING PLANT | EB-235A (MEC4) Boiler Room | Entire Building | FEC-03 | HWS | N/A | Hot Water Heating Plant, 4 Modulating Boilers | |
| MAU-1 | Roof | EB-127 (CAFS) Kitchen | UNT-16 | MAU-1 | N/A | Gas Fired with DX Cooling | |
| RTU-1 | Roof | Serves North West Classroom Addition | DX-2-11 | RTU-1-2-3 | HE-2 | Glycol Heating, Heat Pump, Energy Recovery | Existing control panel located in EB-147 (CS02). |
| RTU-2 | Roof | Serves North East Classroom Addition -Exterior Rooms | DX-2-12 | RTU-1-2-3 | HE-2 | Glycol Heating, Heat Pump, Energy Recovery | Existing control panel located in EB-147 (CS02). |
| RTU-3 | Roof | Serves North East Classroom Addition - Interior Rooms | DX-2-13 | RTU-1-2-3 | HE-2 | Glycol Heating, Heat Pump, Energy Recovery | Existing control panel located in EB-147 (CS02). |
| RTU-4 | Roof | EB-218 (LIB) Learning Commons N-W | TRANE BACNET-3-06 | RTU-4-5 | N/A | Gas Fired, DX Cooling | |
| RTU-5 | Roof | EB-218 (LIB) Learning Commons S-E | TRANE BACNET-3-05 | RTU-4-5 | N/A | Gas Fired, DX Cooling | |
| RTU-6 | Roof | EB-123 (CAF) Cafeteria West | UNT-2-15 | RTU-6 | HE-1 | Glycol Heating, DX Cooling | |
| RTU-7 | Roof | EB-134 (R113)/EB140(R111) Wood and Welding Shop | N/A | RTU-4-5 | N/A | Gas Fired, 100% Outdoor Air | |
| RTU-8 | Roof | EB-150 (115) Auto Shop | N/A | RTU-4-5 | N/A | Gas Fired | |

| CONTROL VALVE SUMMARY | | | | | | |
|---|---|---|---|---|---|---|
| **Room** | **Served by** | **Existing Controller** | **Table Reference** | **Associated Equipment** | **Remarks** | **Keynotes** |
| Corridor Adj EB-108 (R104) | RHC- | UNT-1-57 | RHC CORRIDOR | AHU-1 | Hydronic Reheat | |
| Corridor Adj. EB-104 (S002) | RHC- | UNT-1-62 | RHC CORRIDOR | AHU-1 | Hydronic Reheat | |
| Corridor Adj. EB-111 (VART) | RHC- | UNT-1-130 | RHC CORRIDOR | AHU-3 | Hydronic Reheat | |
| Corridor Adj. EB-120 (R132) | RHC- | UNT-1-137 | RHC CORRIDOR | AHU-3 | Hydronic Reheat | |
| Corridor Adj. EB-128 (CS01) | RHC- | UNT-2-71 | RHC CORRIDOR | AHU-1 | Hydronic Reheat | |
| Corridor Adj. EB-151 (R124) | RHC- | UNT-2-93 | RHC CORRIDOR | RTU-1 | Hydronic Reheat | |
| Corridor Adj. EB-153 (S008) | RHC- | UNT-2-94 | RHC CORRIDOR | RTU-2 | Hydronic Reheat | |
| Corridor Adj. EB-158 (R123) | RHC- | UNT-2-95 | RHC CORRIDOR | RTU-2 | Hydronic Reheat | |
| Corridor Adj. EB-201 (R217) | RHC- | UNT-1-139 | RHC CORRIDOR | AHU-3 | Hydronic Reheat | |
| Corridor Adj. EB-206 (R203) | RHC- | UNT-1-145 | RHC CORRIDOR | AHU-3 | Hydronic Reheat | |
| Corridor Adj. EB-208 (WM01) | RHC- | UNT-1-113 | RHC CORRIDOR | AHU-1 | Hydronic Reheat | |
| Corridor Adj. EB-215 (R208) | RHC- | UNT-1-121 | RHC CORRIDOR | AHU-1 | Hydronic Reheat | |
| Corridor Adj. EB-231 (R216) | RHC- | UNT-1-126 | RHC CORRIDOR | AHU-1 | Hydronic Reheat | |
| EB-100 (R107) Chapel | RHC- | UNT-1-64 | RHC | AHU-1 | Hydronic Reheat | |
| EB-101 (OFF1) Main Office East | RHC- | UNT-1-99 | RHC | AHU-4 | Hydronic Reheat | |
| EB-101 (OFF1) Main Office West | RHC- | UNT-1-101 | RHC | AHU-4 | Hydronic Reheat | |
| EB-101A (OFFP) VP Office | RHC- | UNT-1-97 | RHC RAD | AHU-4 | Hydronic Reheat with Rad | Mechanical contractor to replace existing control valve. Controls contractor to provide VG1000 series control valve or equivalent. |
| EB-101B (WK04) VP Office | RHC- | UNT-1-98 | RHC RAD | AHU-4 | Hydronic Reheat with Rad | Mechanical contractor to replace existing control valve. Controls contractor to provide VG1000 series control valve or equivalent. |
| EB-101C/D (HR01/OFFVP) /Prin. Office/Conf. Room | RHC- | UNT-1-100 | RHC RAD | AHU-4 | Hydronic Reheat with Rad | Mechanical contractor to replace existing control valve. Controls contractor to provide VG1000 series control valve or equivalent. |
| EB-102 (GD01) Guidance | RHC- | UNT-1-63 | RHC | AHU-1 | Hydronic Reheat | |
| EB-103 (HR02) Kitchenette | RHC- | UNT-1-102 | RHC | AHU-4 | Hydronic Reheat | |
| EB-104 (S002) Academic Storage | RHC- | UNT-1-61 | RHC | AHU-1 | Hydronic Reheat | |
| EB-105 (STAF) Staffroom | RHC- | UNT-1-103 | RHC RAD | AHU-4 | Hydronic Reheat with Rad | Mechanical contractor to replace existing control valve. Controls contractor to provide VG1000 series control valve or equivalent. |
| EB-106 (R106) Guidance Office | RHC- | UNT-1-60 | RHC | AHU-1 | Hydronic Reheat | |
| EB-108 (R104) Classroom | RHC- | UNT-1-58 | RHC | AHU-1 | Hydronic Reheat | |
| EB-110 (R102) Classroom | RHC- | UNT-1-56 | RHC | AHU-1 | Hydronic Reheat | |
| EB-111/113B (VART/R137A) Office/Storage | RHC- | UNT-1-131 | RHC | AHU-3 | Hydronic Reheat | |
| EB-113 (R137) Visual Arts Room | RHC- | UNT-1-132 | RHC | AHU-3 | Hydronic Reheat | |
| EB-114 (R101) Music Room | RHC- | UNT-1-52 | RHC | AHU-1 | Hydronic Reheat | |
| EB-114A (S001) Storage (Instruments) | RHC- | UNT-1-53 | RHC | AHU-1 | Hydronic Reheat | |
| EB-114C/D (WK01/WK02) Music Practice Rooms | RHC- | UNT-1-51 | RHC | AHU-1 | Hydronic Reheat | |
| EB-115 (R135) Classroom | RHC- | UNT-1-133 | RHC | AHU-3 | Hydronic Reheat | |
| EB-116 (R136) Classroom | RHC- | UNT-1-134 | RHC | AHU-3 | Hydronic Reheat | |
| EB-117 (R133) Classroom | RHC- | UNT-1-136 | RHC | AHU-3 | Hydronic Reheat | |
| EB-118 (R134) Classroom | RHC- | UNT-1-135 | RHC | AHU-3 | Hydronic Reheat | |
| EB-119 (EL01) Elevator Machine Room | EF-64 | N/A | EF ZNT | N/A | Exhaust Fan with Zone Temp | |
| EB-120 (R132) Classroom | RHC- | UNT-1-138 | RHC | AHU-3 | Hydronic Reheat | |
| EB-121 (R108) Food Services room | RHC- | UNT-1-65 | RHC | AHU-1 | Hydronic Reheat | |
| EB-123 (CAF) /EB-127 (CAFS) Cafeteria East/Servery | AHU-5 | UNT-1-16 | AHU | HE-1 | Glycol Heating, DX Cooling | |
| EB-123 (CAF) Cafeteria West | RTU-6 | UNT-1-15 | RTU | HE-1 | Glycol Heating, DX Cooling | |
| EB-123 (CAF) Cafeteria West Exit | FFH- | N/A | FFH | N/A | Electric FFH | |
| EB-125 (STG) | RHC- | N/A | RHC | AHU-2 | Hydronic Reheat | Mechanical contractor to install new control valve. Controls contractor to provide |
| EB-126 (R109) Exercise Room | RHC- | UNT-67 | RHC | AHU-1 | Hydronic Reheat | |
| EB-127 (CAFS) Kitchen | MAU-1 | UNT- | MAU | N/A | Gas Fired, DX Cooling | |
| EB-128 (CS01) Custodial Office | RHC- | UNT-1-69 | RHC | AHU-1 | Hydronic Reheat | |
| EB-129 (GYMA) Gym South | RHC- | DX-1-02 | RHC | AHU-2 | Hydronic Reheat | |
| EB-129 (GYMA) Gym South Exit | FFH- | N/A | FFH | N/A | Electric Force Flow Heater | |
| EB-129 (GYMB) Gym North | RHC- | DX-1-02 | RHC | AHU-2 | Hydronic Reheat | |
| EB-129 (GYMB) Gym North Exit | FFH- | N/A | FFH | N/A | Electric Force Flow Heater | |
| EB-129A (CRF1) Girls Change Room | RHC- | UNT-2-72 | RHC | AHU-1 | Hydronic Reheat | |
| EB-129B (OFF3) Female Instructors Office | RHC- | UNT-2-70 | RHC | AHU-1 | Hydronic Reheat | |
| EB-129C (OFF2) Male Instructors Office | RHC- | UNT-1-68 | RHC | AHU-1 | Hydronic Reheat | |

| | | | | | | |
|---|---|---|---|---|---|---|
| EB-129D (CRM1) Boys Change Room | RHC- | UNT-1-66 | RHC | AHU-1 | Hydronic Reheat | |
| EB-129E (GMS1) Gym Storage | EF-76 & UH- | N/A | EF UH | N/A | Exhaust Fan & Electric UH | |
| EB-129F (S011) Gym Storage | EF-77 & UH- | N/A | EF UH | N/A | Exhaust Fan & Electric UH | |
| EB-131 (CS03) Recycling Room | EF-78 & UH- | N/A | EF UH | N/A | Exhaust Fan & Hydronic UH | |
| EB-131 (CS03) Recycling Room | RHC- | UNT-2-96 | RHC | AHU-1 | Hydronic Reheat | |
| EB-131B (EL02) Electrical Room | EF-79 & UH- | N/A | EF FFH | N/A | Exhaust Fan & Electric FFH | Outside air damper to be interlocked with exhaust fan command through BAS. |
| EB-133 (WM05) Washrooms | WF- | N/A | RAD/WF | HWS | Hydronic Wallfin | Mechanical contractor to install new control valve supplied by controls contractor. |
| EB-134 (R113) Woodshop | UH- | N/A | UH | HWS | Hydronic Unit Heater | |
| EB-134A (OFF4) Workroom | RHC- | UNT-2-73 | RHC | AHU-1 | Hydronic Reheat | |
| EB-135 (WF05) Washrooms | WF- | N/A | RAD/WF | HWS | Hydronic Wallfin | Mechanical contractor to install new control valve supplied by controls contractor. |
| EB-136 (WM03) Field Use Washroom | FFH- | N/A | FFH | N/A | Electric FFH | |
| EB-137 (R116) Science Lab | RHC- | UNT-2-74 | RHC | RTU-3 | Hydronic Reheat | |
| EB-137A (WK06) Science Prep Room | RHC- | UNT-2-79 | RHC | RTU-1 | Hydronic Reheat | |
| EB-138 (WF03) Field Use Washroom | FFH- | N/A | FFH | N/A | Electric FFH | |
| EB-139 (S009) Prep Room | RHC- | UNT--2-76 | RHC | RTU-3 | Hydronic Reheat | |
| EB-140A (OFF4) Teacher Workroom | RHC- | UNT- | RHC | AHU-1 | Hydronic Reheat | |
| EB-141 (R118) Classroom | RHC- | UNT-2-80 | RHC | RTU-1 | Hydronic Reheat | |
| EB-143 (R120) Classroom | RHC- | UNT-2-81 | RHC | RTU-1 | Hydronic Reheat | |
| EB-145 (WK05) Teacher Work Room | RHC- | UNT-2-82 | RHC | RTU-1 | Hydronic Reheat | |
| EB-149 (R122) Life Skills room | RHC- | UNT--2-78 | RHC | RTU-1 | Hydronic Reheat | |
| EB-150 (R115) Autoshop - North | UH- | N/A | UH | HWS | Hydronic Unit Heater | |
| EB-150 (R115) Autoshop - South | UH- | N/A | UH | HWS | Hydronic Unit Heater | |
| EB-150A (R111) Welding Shop | UH- | N/A | UH | HWS | Hydronic Unit Heater | |
| EB-151 (R124) Program Support Office | RHC- | UNT-2-77 | RHC | RTU-1 | Hydronic Reheat | |
| EB-151A (TUCK) Office | RHC- | UNT-2-75 | RHC | RTU-3 | Hydronic Reheat | |
| EB-152 (R117) Classroom | RHC- | UNT--2-83 | RHC | RTU-3 | Hydronic Reheat | |
| EB-154 (R119) Drama Room | RHC- | UNT-2-84 | RHC | RTU-3 | Hydronic Reheat | |
| EB-156 (R121) Credit Recovery Room | RHC- | UNT-2-85 | RHC | RTU-3 | Hydronic Reheat | |
| EB-157 (R126) Classroom | RHC- | UNT-2-87 | RHC | RTU-2 | Hydronic Reheat | |
| EB-158 (R123) Computer Lab | RHC- | UNT-2-86 | RHC | RTU-3 | Hydronic Reheat | |
| EB-159 (R131) Classroom | RHC- | UNT-2-88 | RHC | RTU-2 | Hydronic Reheat | |
| EB-160 (R125) Computer Lab | RHC- | UNT-2-92 | RHC | RTU-2 | Hydronic Reheat | |
| EB-161 (R129) Classroom | RHC- | UNT-2-89 | RHC | RTU-2 | Hydronic Reheat | |
| EB-163 (R127) Classroom | RHC- | UNT-2-90 | RHC | RTU-2 | Hydronic Reheat | |
| EB-167 (OFF5)Office | RHC- | UNT-2-91 | RHC | RTU-2 | Hydronic Reheat | |
| EB-200 (R218) Classroom | RHC- | UNT-1-141 | RHC | AHU-3 | Hydronic Reheat | |
| EB-201 (R217) Classroom | RHC- | UNT-1-140 | RHC | AHU-3 | Hydronic Reheat | |
| EB-202 (R220) Classroom | RHC- | UNT-1-143 | RHC | AHU-3 | Hydronic Reheat | |
| EB-203 (R219) Classroom | RHC- | UNT-1-142 | RHC | AHU-3 | Hydronic Reheat | |
| EB-204 (R221) Classroom | RHC- | UNT-1-144 | RHC | AHU-3 | Hydronic Reheat | |
| EB-205 (MEC1) | UH-& VD-1 | DX-2-20 | VD UH | HWS | Vent Damper & Hydronic UH | |
| EB-206 (R023) Academic room | RHC- | UNT-1-146 | RHC | AHU-3 | Hydronic Reheat | |
| EB-207 (R101)Teacher Workroom | RHC- | UNT-1-111 | RHC | AHU-1 | Hydronic Reheat | |
| EB-208 (WM01)Boys Washrooms | RAD- | UNT-1-19 | RAD/WF | HWS | Hydronic Rad | |
| EB-209 (R202) Classroom | RHC- | UNT-1-112 | RHC | AHU-1 | Hydronic Reheat | |
| EB-210 (WF01) Girls Washrooms | RAD- | UNT-1-19 | RAD/WF | HWS | Hydronic Rad | |
| EB-211 (R204) Classroom | RHC- | UNT-1-114 | RHC | AHU-1 | Hydronic Reheat | |
| EB-212 (R205) Chemistry Lab | RHC- | UNT-1-117 | RHC | AHU-1 | Hydronic Reheat | |
| EB-212A (WK01) Preproom/Bio. Lab | RHC- | UNT-1-118 | RHC | AHU-1 | Hydronic Reheat | |
| EB-213 (R206) Classroom | RHC- | UNT-1-116 | RHC | AHU-1 | Hydronic Reheat | |
| EB-215 (R208) Classroom | RHC- | UNT-1-119 | RHC | AHU-1 | Hydronic Reheat | |
| EB-216 Biology lab | RHC- | UNT-1-120 | RHC | AHU-1 | Hydronic Reheat | Demo redundant controller |
| EB-217 (S001) Acedemic Storge | UH- | N/A | UH | N/A | Electric Baseboard | |
| EB-217A (EL01) Electrical Room | EF-24 | N/A | EF ZNT | N/A | Exhaust Fan with Zone Temp | |
| EB-218 (LIB) Learning Commons N-W | BPD-1 | TEC-3-07 | BPD | RTU-4 | Bypass Damper | |
| EB-218 (LIB) Learning Commons N-W | RTU-4 | TRANE BACNET-3-06 | RTU | N/A | Gas Fired, DX Cooling | |
| EB-218 (LIB) Learning Commons S-E | RTU-5 | TRANE BACNET-3-05 | RTU | N/A | Gas Fired, DX Cooling | |
| EB-223 (R210) Classroom | RHC- | UNT-1-112 | RHC | AHU-1 | Hydronic Reheat | |
| EB-224 Classroom | RHC- | UNT-1-125 | RHC | AHU-1 | Hydronic Reheat | Demo redundant controller |
| EB-225 (R212) Classroom | RHC- | UNT-1-123 | RHC | AHU-1 | Hydronic Reheat | |
| EB-227 (R214) Classroom | RHC- | UNT-1-124 | RHC | AHU-1 | Hydronic Reheat | |

| | | | | | | |
|---|---|---|---|---|---|---|
| EB-229 (MEC3) Mechanical Room | UH- | N/A | UH | HWS | Hydronic Unit Heater | |
| EB-231 (R216) Student Services | RHC- | UNT-1-17 | RHC | AHU-1 | Hydronic Reheat | |
| EB-233 (R213) PLR | RHC- | UNT-1-127 | RHC | AHU-1 | Hydronic Reheat | |
| EB-233A (OFF2) PLR | RHC- | UNT-1-129 | RHC | AHU-1 | Hydronic Reheat | |
| EB-233B (ST04) PLR Storage | RHC- | UNT-1-128 | RHC | AHU-1 | Hydronic Reheat | |
| EB-235 (MEC6) Mechanical Room | EF-30 & UH- | DX-2-21 | EF UH | N/A | Hydronic UH | |
| EB-235A (MEC4) Boiler Room | EF-29 & UH- | FEC-2-03 | EF UH | N/A | Hydronic UH | |
| EB-EXIT C (V001) | FFH- | N/A | FFH | HWS | Hydronic FFH | |
| EB-EXIT C (V001) | FFH- | N/A | FFH | HWS | Hydronic FFH | |
| EB-EXIT D (V003) | FFH- | N/A | FFH | HWS | Hydronic FFH | |
| EB-EXIT E (V004) | FFH- | N/A | FFH | HWS | Hydronic FFH | |
| EB-EXIT F | FFH- | N/A | FFH | HWS | Hydronic FFH | |
| EB-MAIN EXIT (V005) | FFH- | N/A | FFH | HWS | Hydronic FFH | |
| EB-STAIR A (ST01) | FFH- | N/A | FFH | HWS | Hydronic FFH | |
| EB-STAIR B (ST02) | FFH- | N/A | FFH | HWS | Hydronic FFH | |
| EB-STAIR G (ST05) | FFH- | N/A | FFH | HWS | Hydronic FFH | |

| EXHAUST FAN SUMMARY | | | | |
|---|---|---|---|---|
| **Equipment Tag** | **Serving** | **Table Reference** | **Control** | **Keynotes** |
| EF-01 | EB-107/109/208/210 (WF01/WM01) Washrooms | EF | BAS Command | |
| EF-02 | EB-212(R205) Chemistry Lab | EF | BAS Enable | |
| EF-03 | EB-215 (R208) Classroom | EF | BAS Enable | |
| EF-04 | EB-133/135 (WM05/WF05) Washrooms | EF | BAS Command | |
| EF-05 | EB-137 (R116) Science Classroom | EF | BAS Enable | |
| EF-06 | EB-152 (R117) Classroom | EF | BAS Command | |
| EF-07 | EB-152 (R117) Classroom | EF | BAS Command | |
| EF-08 | EB-137 (R116) Science Classroom | EF | BAS Enable | Interlock with MD |
| EF-09 | EB-141 (R118) Science Classroom | EF | BAS Enable | Interlock with MD |
| EF-10 | EB-141 (R118) Science Classroom | EF | BAS Enable | |
| EF-11 | EB-150A (R111) Welding Shop | EF | BAS Monitor | |
| EF-12 | EB-122/124 (WM02/WF02) Washrooms | EF | BAS Command | |
| EF-13 | EB-121 (R108) Food Services room | EF | BAS Enable | |
| EF-14 | EB-119 (EL01) Elevator Machine Room | EF | BAS Enable | |
| EF-15 | EB-150 (R115) Autoshop Commercial Demo | EF | BAS Enable | Interlock with RTU-7 |
| EF-16 | EB-150 (R115) Autoshop Tailpipe | EF | | |
| EF-17 | EB-212(R205) Chemistry Lab Fume Hood | | | |
| EF-18 | EB-212(R205) Chemistry Lab | | BAS Enable | |
| EF-22 | EB-212A (WK01) Preproom/Bio. Lab | EF | BAS Enable | |
| EF-23 | EB-217 (S001) Academic Storage | EF UH | BAS Enable | |
| EF-24 | EB-217A (EL01) Electrical Room | EF | BAS Temperature Control | |
| EF-25 | EB-215A (S002) | EF | BAS Enable | |
| EF-26 | EB-219 (CS01) Custodial Storage | EF | BAS Enable | |
| EF-27 | EB-221 (CS02) Custodial Slop Room | EF | BAS Enable | |
| EF-28 | EB-129A/D (CRF1/CRM1) Girls/Boys Change Rooms | EF | BAS Command | |
| EF-29 | EB-235A (MEC4) Boiler Room | EF UH | BAS Temperature Control | Interlock with MD |
| EF-30 | EB-235 (MEC6) Mechanical Room | EF UH | BAS Temperature Control | Interlock with MD |
| EF-61 | EB-115A (R135A) Kiln Room | EF | BAS Enable | C/W high temperature fire stat. Manual On/Off |
| EF-62 | EB-105 Range Hood | | | |
| EF-63 | EB-105A/B (WM06/WF06) Staff Washrooms | EF | BAS Enable | |
| EF-67 | EB-127 (CAFS) Kitchen | EF | BAS Command | |
| EF-68 | EB-127 (CAFS) Kitchen | EF | BAS Enable | Kitchen Hood Exhaust Fan. Interlock with MAU-1 through BAS. |
| EF-69 | EB-136 (WM03) Field Use Washroom | EF | BAS Enable | And BAS Temperature Control |
| EF-70 | EB-138 (WF03) Field Use Washroom | EF | BAS Enable | And BAS Temperature Control |
| EF-71 & SF-01 | EB-134B (S004) Finishing Room | EF SF | BAS Enable | Interlock with SF-1 through BAS. |
| EF-73 | EB-132 (S003) Slop Room | EF | BAS Enable | |
| EF-74 | EB-128A (WR01) Custodial Office Washroom | EF | BAS Enable | |
| EF-76 | EB-129E (GMS1) Gym Storage | EF UH | BAS Temperature Control | |
| EF-77 | EB-129F (S011) Gym Storage | EF UH | BAS Temperature Control | |
| EF-78 | EB-131 (CS03) Recycling Room | EF OAD UH | BAS Temperature Control | Outside air damper to be interlocked with exhaust fan command through BAS. |
| EF-79 | EB-131B (EL02) Electrical Room | EF FFH | BAS Temperature Control | |
| EF-80 | EB-144/146 (WM04/WF04) Washrooms | EF | BAS Command | |
| EF-83 | EB-139 (S009) Prep Room | EF | BAS Enable | Interlock with MD |
| EF-86 | EB-147 (CS02)Slop Room | EF | BAS Enable | Interlock with MD |

| RTU-1, RTU,2, RTU-3 North Classroom Addition | | |
|---|---|---|
| **Point Name** | **Point Type** | **Keynotes** |
| Return Air CO2 | AI | Existing CO2 sensors terminated to control panel in room EB-107 (CS02). Sensor to be replaced with Veris CDE series or equivalent. |
| Discharge Air Temperature | BACnet | |
| Leaving Coil/Entering Fan Temperature | BACnet | |
| Building Static Pressure Sensor | BACnet | |
| Return Air Temperature | BACnet | |
| Return Air Humidity | BACnet | |
| Outside Air Temperature | BACnet | |
| Supply Fan Air Proving Via Modbus | BACnet | |
| Supply Leaving Wheel Temperature Sensor | BACnet | |
| Exhaust Leaving Wheel Temperature Sensor | BACnet | |
| Dirty Filter On/Off Switch | BACnet | |
| Duct High Limit Switch | BACnet | |
| Energy Wheel VFD | BACnet | |
| **General Notes** | | |
| BAS to communicate with Daikin RTU via BACnet MSTP. See sequence of operation in specifications for full list of BACnet points. | | |
| Re-use existing control panel. Re-label panel with new device address | | |

| RTU-4, RTU-5 Learning Commons | | |
|---|---|---|
| **Point Name** | **Point Type** | **Keyed Notes** |
| Zone Temperature | AI | Existing zone sensors terminated to NCE. Demo and replace with NSB8MTC040-0 or equivilant. Wire to new BACnet controller. |
| Motion Sensor | BI | NSB8MTN040-0 or equivilant |
| Zone CO2 | AI | NSB8MTN040-0 or equivilant |
| Discharge Air Temperature | AI | New point. |
| Return Air Temperature | AI | New point. |
| **General Notes** | | |
| BAS to communicate with Trane RTU via BACnet MSTP. See sequence of operation in specifications for list of BACnet points. | | |

| RTU-6 West Cafeteria | | | | | |
|---|---|---|---|---|---|
| **Point Name** | **Hardware Points** | | | | **Keynotes** |
| | **AI** | **AO** | **BI** | **BO** | |
| Zone Temperature | x | | | | Replace with NSB8MTN040-0 or equivalent. |
| Motion Sensor Status | | | x | | NSB8MTN040-0 or equivalent. |
| Discharge Air Temperature 1 | x | | | | |
| Discharge Air Temperature 2 | x | | | | |
| Low Temperature Alarm 1 | | | x | | New point. A70HA-1C or equivalent. |
| Low Temperature Alarm 2 | | | x | | New point. A70HA-1C or equivalent. |
| Supply Fan Command | | | | x | |
| Supply Fan Amps | x | | | | Digital current sensor to be replaced with analog current sensor. |
| Supply Fan Alarm | | | x | | |
| Exhaust Fan Amps | x | | | | New point. Analog current sensor |
| Outdoor Damper Enable | | | | x | |
| Return Air Temperature | x | | | | New point. |
| Mixed Air Temperature | x | | | | New point. |
| Reheat Valve 1 Output | | x | | | |
| Reheat Valve 2 Output | | x | | | |
| Cooling Stage 1 Command | | | | x | |
| Cooling Stage 2 Command | | | | x | |
| Filter Differential Pressure | x | | | | New point. MSX-W12-IN-LCD or equivalent. |
| **General Notes** | | | | | |
| All hardware points are existing unless otherwise specified. | | | | | |
| All existing temperature sensors to be replaced. | | | | | |
| Control wiring can be re-used if not part of communication trunk. | | | | | |
| Controller power to be re-used. | | | | | |
| Re-use existing control panel. Re-label panel with new device address | | | | | |

| RTU-7 - Wood and Welding Shop | | |
|---|---|---|
| **Point Name** | **Point Type** | **Keynotes** |
| Zone Temperature | AI | New point. TE200AS12 stainless steel wallplate or equivalent. |
| Dust Collector Status | BI | New point. |
| Discharge Air Temperature | BACnet | |
| Leaving Coil/Entering Fan Temperature | BACnet | |
| Outside Air Temperature | BACnet | |
| Supply Fan Air Proving Via Modbus | BACnet | |
| Dirty Filter On/Off Switch | BACnet | |
| Duct High Limit Switch | BACnet | |
| **General Notes** | | |
| BAS to communicate with Daikin RTU via BACnet MSTP. See sequence of operation in specifications for full list of BACnet points. | | |

| RTU-8 - Auto Shop | | |
|---|---|---|
| **Point Name** | **Hardware Points** | **Keynotes** |
| Zone Temperature | AI | New point. TE200AS12 stainless steel wallplate or equivalent. |
| Tailpipe Exhaust Fan Status | BI | New point. |
| Discharge Air Temperature | BACnet | |
| Leaving Coil/Entering Fan Te | BACnet | |
| Outside Air Temperature | BACnet | |
| Supply Fan Air Proving Via M | BACnet | |
| Dirty Filter On/Off Switch | BACnet | |
| Duct High Limit Switch | BACnet | |
| Return Air Temperature | BACnet | |
| Return Air Humidity | BACnet | |
| **General Notes** | | |
| BAS to communicate with Daikin RTU via BACnet MSTP. See sequence of operation in specifications for full list of BACnet points. | | |

| AHU-1 Central Classrooms | | | | | |
|---|---|---|---|---|---|
| Point Name | Hardware | | | | Keynotes |
| | AI | AO | BI | BO | |
| Discharge Air Temperature | x | | | | |
| Supply Fan Command | | | | x | |
| Supply Fan Output (Fixed %) | | x | | | |
| Supply Fan Amps | x | | | | Analog current sensor |
| Return Fan Command | | | | x | |
| Return Fan Output (Fixed %) | | x | | | |
| Return Fan Amps | x | | | | Analog current sensor |
| Low Temperature Alarm | | | x | | A70HA-1C or equivalent. |
| Return Air Temperature | x | | | | |
| Mixed Air Temperature | x | | | | |
| Return Air CO2 | x | | | | Veris CDE series or equivalent. |
| Filter Differential Pressure | x | | | | MSX-W12-IN-LCD or equivalent. |
| Heating Valve Output | | x | | | |
| Cooling Stage 1 Command | | | | x | |
| Cooling Stage 2 Command | | | | x | |
| Cooling Stage 3 Command | | | | x | |
| Cooling Stage 4 Command | | | | x | |
| Cooling Stage 5 Command | | | | x | |
| Cooling Stage 6 Command | | | | x | |
| Mixed Air Damper Output | | x | | | |
| Supply Fan Kilowatts | x | | | | Kilowatt value from VFD |
| Supply Fan VFD Alarm | | | x | | Alarm value from VFD |
| Return Fan Kilowatts | x | | | | Kilowatt value from VFD |
| Return Fan VFD Alarm | | | x | | Alarm value from VFD |
| ERV Exhaust Air Temperature | x | | | | |
| ERV Control | | | | x | |
| ERV Modulation | | x | | | |
| ERV Return Air Damper Output | | x | | | |
| ERV Supply Air Temperature | x | | | | |
| ERV Supply Air Damper Output | | x | | | |
| General Notes | | | | | |
| Control Panel to be replaced with new. | | | | | |
| Controller power to be re-used. | | | | | |
| All control wiring, actuators and sensors to be new. | | | | | |

| AHU-2 Gym | | | | | |
|---|---|---|---|---|---|
| **Point Name** | **Hardware** | | | | **Keynotes** |
| | **AI** | **AO** | **BI** | **BO** | |
| Discharge Air Temperature | x | | | | |
| Supply Fan Command | | | | x | |
| Supply Fan Output (Fixed %) | | x | | | |
| Supply Fan Amps | x | | | | Analog current sensor |
| Return Fan Command | | | | x | |
| Return Fan Output (Fixed %) | | x | | | |
| Return Fan Amps | x | | | | Analog current sensor |
| North Gym Motion Sensor | | | x | | To be protected with wire guard cover. |
| South Gym Motion Sensor | | | x | | To be protected with wire guard cover. |
| North Gym Zone Temperature | x | | | | Existing wire to be re-used. Replace with TE200AS12 stainless steel wallplate or equivalent. |
| North Gym Reheat Valve Output | | x | | | Veris CDE series or equivalent. |
| North Gym Discharge Air Temperature | x | | | | |
| South Gym Zone Temperature | x | | | | Existing wire to be re-used. Replace with TE200AS12 stainless steel wallplate or equivalent. |
| South Gym Reheat Valve Output | | x | | | |
| South Gym Discharge Air Temperature | x | | | | |
| Stage Zone Temperature | x | | | | TE200AS12 stainless steel wallplate or equivalent. |
| Stage Reheat Valve Output | | x | | | |
| Stage Discharge Air Temperature | x | | | | |
| Low Temperature Alarm | | | x | | A70HA-1C or equivalent. |
| Return Air Temperature | x | | | | |
| Mixed Air Temperature | x | | | | |
| Return Air CO2 | x | | | | Veris CDE series or equivalent. |
| Heating Valve Output | | x | | | |
| Cooling Stage 1 Command | | | | x | |
| Cooling Stage 2 Command | | | | x | |
| Cooling Stage 3 Command | | | | x | |
| Mixed Air Damper Output | | x | | | |
| Supply Fan Kilowatts | x | | | | Kilowatt value from VFD |
| Supply Fan VFD Alarm | | | x | | Alarm value from VFD |
| Return Fan Kilowatts | x | | | | Kilowatt value from VFD |
| Return Fan VFD Alarm | | | x | | Alarm value from VFD |
| ERV Exhaust Air Temperature | x | | | | |
| ERV Control | | | | x | |
| ERV Modulation | | x | | | |
| ERV Return Air Damper Output | | x | | | |
| ERV Supply Air Temperature | x | | | | |
| ERV Supply Air Damper Output | | x | | | |
| **General Notes** | | | | | |
| Control Panel to be replaced with new. | | | | | |
| Controller power to be re-used. | | | | | |
| All control wiring, actuators and sensors to be new unless specified. | | | | | |

| AHU-3 South Addition | | | | | |
|---|---|---|---|---|---|
| **Point Name** | **Hardware Points** | | | | **Keynotes** |
| | **AI** | **AO** | **BI** | **BO** | |
| Discharge Air Temperature | x | | | | |
| Supply Fan Command | | | | x | To be terminated to new VFD |
| Supply Fan Output (Fixed %) | | x | | | New point. To be terminated to new VFD |
| Supply Fan Amps | x | | | | Digital current sensor to be replaced with analog current sensor |
| Return Fan Command | | | | x | To be terminated to new VFD |
| Return Fan Output (Fixed %) | | x | | | New point. To be terminated to new VFD |
| Return Fan Amps | x | | | | Digital current sensor to be replaced with analog current sensor |
| Low Temperature Alarm | | | x | | Replace with A70HA-1C or equivalent |
| Return Air Temperature | x | | | | |
| Mixed Air Temperature | x | | | | |
| Return Air CO2 | x | | | | Replace with Veris CDE series or equivalent. |
| Filter Differential Pressure | | | | | New point. MSX-W12-IN-LCD or equivalent. |
| Heating Valve Output | | x | | | |
| Cooling Stage 1 Command | | | | x | New point |
| Cooling Stage 2 Command | | | | x | New point |
| Cooling Stage 3 Command | | | | x | New point |
| Cooling Stage 4 Command | | | | x | New point |
| Mixed Air Damper Output | | x | | | |
| Supply Fan Kilowatts | x | | | | New Point. Kilowatt value from VFD |
| Supply Fan VFD Alarm | | | x | | New Point. Alarm value from VFD |
| Return Fan Kilowatts | x | | | | New Point. Kilowatt value from VFD |
| Return Fan VFD Alarm | | | x | | New Point. Alarm value from VFD |
| **General Notes** | | | | | |
| Points are existing unless otherwise specified. | | | | | |
| All existing temperature sensors to be replaced. | | | | | |
| Control wiring can be re-used if not part of communication trunk. | | | | | |
| Controller power to be re-used. | | | | | |
| Re-use existing control panel. Re-label panel with new device address | | | | | |

| AHU-4 Administration | | | | | |
|---|---|---|---|---|---|
| **Point Name** | **Hardware Points** | | | | **Keynotes** |
| | **AI** | **AO** | **BI** | **BO** | |
| Discharge Air Temperature | x | | | | |
| Supply Fan Command | | | | x | To be terminated to new VFD. |
| Supply Fan Output (Fixed %) | | x | | | New point. To be terminated to new VFD. |
| Supply Fan Amps | x | | | | Digital current sensor to be replaced with analog current sensor |
| Return Fan Command | | | | x | To be terminated to new VFD. |
| Return Fan Output (Fixed %) | | x | | | New point. To be terminated to new VFD. |
| Return Fan Amps | x | | | | Digital current sensor to be replaced with analog current sensor |
| Low Temperature Alarm | | | x | | Existing freeze stat to be replaced with A70HA-1C or equivalent. New status to be wired to BAS. |
| Return Air Temperature | x | | | | |
| Mixed Air Temperature | x | | | | |
| Return Air CO2 | x | | | | Replace with Veris CDE series or equivalent. |
| Filter Differential Pressure | x | | | | New point. MSX-W12-IN-LCD or equivalent. |
| Heating Valve Output | | x | | | |
| Heat Pump Command | | | | x | Enable command to heat pump |
| Cooling/Heating Output | | x | | | 0-10VDC capacity control to heat pump |
| Cooling/Heating Mode | | | | x | Cool/Heat Mode command to heat pump |
| Fan Interlock | | | x | | |
| Heat Pump On/Off Status | | | x | | |
| Heat Pump Defrost Mode Status | | | x | | |
| Heat Pump Alarm | | | x | | |
| Mixed Air Damper Output | | x | | | |
| Supply Fan Kilowatts | x | | | | New point. Kilowatt value from VFD |
| Supply Fan VFD Alarm | | | x | | New point. Alarm value from VFD |
| Return Fan Kilowatts | x | | | | New point. Kilowatt value from VFD |
| Return Fan VFD Alarm | | | x | | New point. Alarm value from VFD |
| **General Notes** | | | | | |
| Points are existing unless otherwise specified. | | | | | |
| All existing temperature sensors to be replaced. | | | | | |
| Control wiring can be re-used if not part of communication trunk. | | | | | |
| Controller power to be re-used. | | | | | |
| Re-use existing control panel. Re-label panel with new device address | | | | | |

| AHU-5 East Cafeteria and Servery | | | | | |
|---|---|---|---|---|---|
| **Point Name** | **Hardware Points** | | | | **Keynotes** |
| | **AI** | **AO** | **BI** | **BO** | |
| Zone Temperature | x | | | | Replace with MSB8MTN040-0 or equivalent. |
| Motion Sensor Status | | | x | | MSB8MTN040-0 or equivalent. |
| Discharge Air Temperature | x | | | | |
| Supply Fan Command | | | | x | |
| Supply Fan Amps | x | | | | Digital current sensor to be replaced with analog current sensor |
| Damper Enable | | | | x | |
| Return Air Temperature | x | | | | Existing freeze stat to be replaced with A70HA-1C or equivalent. New status to be wired to BAS. |
| Heating Valve Output | | x | | | |
| Cooling Stage 1 Command | | | | x | |
| Cooling Stage 2 Command | | | | x | |
| Filter Differential Pressure | | | | | New point. MSX-W12-IN-LCD or equivalent. |
| **General Notes** | | | | | |
| Points are existing unless otherwise specified. | | | | | |
| All existing temperature sensors to be replaced. | | | | | |
| Control wiring can be re-used if not part of communication trunk. | | | | | |
| Controller power to be re-used. | | | | | |
| Replace existing control panel with new. | | | | | |

| MAU-1 Kitchen | | | | | |
|---|---|---|---|---|---|
| **Point Name** | **Hardware Points** | | | | **Keynotes** |
| | **AI** | **AO** | **BI** | **BO** | |
| Zone Temperature | x | | | | |
| Discharge Air Temperature | x | | | | |
| Unit Enable | | | | x | |
| Supply Fan Amps | x | | | | New point. |
| Kitchen Hood Exhaust Fan Amps | x | | | | New point. Analog current sensor |
| Filter Differential Pressure | x | | | | New point. MSX-W12-IN-LCD or equivalent. |
| **General Notes** | | | | | |
| Points are existing unless otherwise specified. | | | | | |
| All existing temperature sensors to be replaced. | | | | | |
| Control wiring can be re-used if not part of communication trunk. | | | | | |
| Controller power to be re-used. | | | | | |

| Heating Plant | | | | | |
|---|---|---|---|---|---|
| **Point Name** | **Hardware Points** | | | | **Keynotes** |
| | **AI** | **AO** | **BI** | **BO** | |
| Hot Water Supply Temperature | x | | | | |
| Hot Water Return Temperature | x | | | | |
| Outdoor Air Temperature | x | | | | |
| Boiler 1 Command | | | | x | |
| Boiler 1 Output | | x | | | |
| Boiler 1 Status | | | x | | |
| Boiler 1 Alarm | | | x | | |
| Boiler 1 Entering Water Temperature | x | | | | |
| Boiler 1 Leaving Water Temperature | x | | | | |
| Boiler 2 Command | | | | x | |
| Boiler 2 Output | | x | | | |
| Boiler 2 Status | | | x | | |
| Boiler 2 Alarm | | | x | | |
| Boiler 2 Entering Water Temperature | x | | | | |
| Boiler 2 Leaving Water Temperature | x | | | | |
| Boiler 3 Command | | | | x | |
| Boiler 3 Output | | x | | | |
| Boiler 3 Status | | | x | | |
| Boiler 3 Alarm | | | x | | |
| Boiler 3 Entering Water Temperature | x | | | | |
| Boiler 3 Leaving Water Temperature | x | | | | |
| Boiler 4 Command | | | | x | |
| Boiler 4 Output | | x | | | |
| Boiler 4 Status | | | x | | |
| Boiler 4 Alarm | | | x | | |
| Boiler 4 Entering Water Temperature | x | | | | |
| Boiler 4 Leaving Water Temperature | x | | | | |
| Boiler 1 Circ. Pump Command | | | | x | |
| Boiler 1 Circ. Pump Amperage | x | | | | Digital current sensor to be replaced with analog current sensor |
| Boiler 2 Circ. Pump Command | | | | x | |
| Boiler 2 Circ. Pump Amperage | x | | | | Digital current sensor to be replaced with analog current sensor |
| Boiler 2 Circ. Pump Command | | | | x | |
| Boiler 3 Circ. Pump Amperage | x | | | | Digital current sensor to be replaced with analog current sensor |
| Boiler 4 Circ. Pump Command | | | | x | |
| Boiler 4 Circ. Pump Amperage | x | | | | Digital current sensor to be replaced with analog current sensor |
| Hot Water Pump 9 Command | | | | x | |
| Hot Water Pump 9 Output | | x | | | |
| Hot Water Pump 9 Amperage | x | | | | Digital current sensor to be replaced with analog current sensor |
| Hot Water Pump 10 Command | | | | x | |
| Hot Water Pump 10 Output | | x | | | |
| Hot Water Pump 10 Amperage | x | | | | Digital current sensor to be replaced with analog current sensor |
| **General Notes** | | | | | |
| Points are existing unless otherwise specified. | | | | | |
| All existing temperature sensors to remain. | | | | | |
| Control wiring can be re-used if not part of communication trunk. | | | | | |
| Controller power to be re-used. | | | | | |
| Re-use existing control panel. Re-label panel with new device address | | | | | |

| Heat Exchanger 1 - Main School | | | | | |
|---|---|---|---|---|---|
| **Point Name** | **Hardware Points** | | | | **Keynotes** |
| | **AI** | **AO** | **BI** | **BO** | |
| Glycol Pump 7 Command | | | | x | |
| Glycol Pump 7 Amperage | x | | | | Digital current sensor to be replaced with analog current sensor |
| Glycol Pump 8 Command | | | | x | |
| Glycol Pump 8 Amperage | x | | | | Digital current sensor to be replaced with analog current sensor |
| Heat Exchanger 1 Hot Water Entering Temp | x | | | | |
| Heat Exchanger 1 Hot Water Leaving Temp | x | | | | |
| Heat Exchanger 1 Glycol Entering Temp | x | | | | |
| Heat Exchanger 1 Glycol Leaving Temp | x | | | | |
| **General Notes** | | | | | |
| Points are existing unless otherwise specified. | | | | | |
| All existing temperature sensors to remain. | | | | | |
| Control wiring can be re-used if not part of communication trunk. | | | | | |
| Controller power to be re-used. | | | | | |

| Heat Exchanger 2 - North Addition | | | | | |
|---|---|---|---|---|---|
| **Point Name** | **Hardware Points** | | | | **Keynotes** |
| | **AI** | **AO** | **BI** | **BO** | |
| Glycol Pump 5 Command | | | | x | |
| Glycol Pump 5 Amperage | x | | | | Digital current sensor to be replaced with analog current sensor |
| Glycol Pump 6 Command | | | | x | |
| Glycol Pump 6 Amperage | x | | | | Digital current sensor to be replaced with analog current sensor |
| Heat Exchanger 2 Hot Water Entering Temp | x | | | | |
| Heat Exchanger 2 Hot Water Leaving Temp | x | | | | |
| Heat Exchanger 2 Glycol Entering Temp | x | | | | |
| Heat Exchanger 2 Glycol Leaving Temp | x | | | | |
| **General Notes** | | | | | |
| Points are existing unless otherwise specified. | | | | | |
| All existing temperature sensors to remain. | | | | | |
| Control wiring can be re-used if not part of communication trunk. | | | | | |
| Controller power to be re-used. | | | | | |

| Heat Exchanger 3 - South Addition | | | | | |
|---|---|---|---|---|---|
| **Point Name** | **Hardware Points** | | | | **Keynotes** |
| | **AI** | **AO** | **BI** | **BO** | |
| Glycol Pump 10 Command | | | | x | |
| Glycol Pump 10 Amperage | x | | | | Digital current sensor to be replaced with analog current sensor |
| Heat Exchanger 3 Glycol Entering Temp | x | | | | New point. Strap on sensor. |
| Heat Exchanger 3 Glycol Leaving Temp | x | | | | New point. Strap on sensor. |
| **General Notes** | | | | | |
| Points are existing unless otherwise specified. | | | | | |
| Control wiring can be re-used if not part of communication trunk. | | | | | |
| Controller power to be re-used. | | | | | |

| Hydronic Reheat Coil | | | | | |
|---|---|---|---|---|---|
| **Point Name** | **Hardware Points** | | | | **Keynotes** |
| | **AI** | **AO** | **BI** | **BO** | |
| Zone Temperature | x | | | | Replace with NSB8MTN240-0 combo sensor or equivalent. |
| Warmer/Cooler Adjust | x | | | | Included with NSB8MTN240-0 combo sensor |
| Zone Temporary Occupancy | | | x | | Included with NSB8MTN240-0 combo sensor |
| Motion Sensor | | | x | | Included with NSB8MTN240-0 combo sensor |
| Discharge Air Temperature | x | | | | New point. Install downstream of reheat coil |
| Reheat Valve Output | | x | | | |
| **General Notes** | | | | | |
| Points are existing unless otherwise specified. | | | | | |
| Control wiring can be re-used if not part of communication trunk. | | | | | |
| Controller power to be re-used. | | | | | |
| Re-use existing control panel. Re-label panel with new device address | | | | | |

| Hydronic Reheat Coil - Corridor | | | | | |
|---|---|---|---|---|---|
| **Point Name** | **Hardware Points** | | | | **Keynotes** |
| | **AI** | **AO** | **BI** | **BO** | |
| Zone Temperature | x | | | | Replace with TE200AS12 stainless steel wallplate or equivalent. Demo existing guards. |
| Discharge Air Temperature | x | | | | New point. Install downstream of reheat coil |
| Reheat Valve Output | | x | | | |
| **General Notes** | | | | | |
| Points are existing unless otherwise specified. | | | | | |
| Control wiring can be re-used if not part of communication trunk. | | | | | |
| Controller power to be re-used. | | | | | |
| Re-use existing control panel. Re-label panel with new device address | | | | | |

| Hydronic Reheat Coil with Radiant Perimeter Heating | | | | | |
|---|---|---|---|---|---|
| **Point Name** | **Hardware** | | | | **Keynotes** |
| | **AI** | **AO** | **BI** | **BO** | |
| Zone Temperature | x | | | | Replace with NSB8MTN240-0 combo senser or equivalent. |
| Warmer/Cooler Adjust | x | | | | Included with NSB8MTN240-0 combo sensor |
| Zone Temporary Occupancy | | | x | | Included with NSB8MTN240-0 combo sensor |
| Motion Sensor | | | x | | Included with NSB8MTN240-0 combo sensor |
| Discharge Air Temperature | x | | | | New point. Install downstream of reheat coil |
| Reheat Valve Output | | x | | | |
| Perimeter Heating Valve Output | | x | | | Replace |
| **General Notes** | | | | | |
| Points are existing unless otherwise specified. | | | | | |
| Control wiring can be re-used if not part of communication trunk. | | | | | |
| Controller power to be re-used. | | | | | |
| Re-use existing control panel. Re-label panel with new device address | | | | | |
| Mechanical contractor to install new control valve supplied by controls contractor. VG1000 series or equivalent. | | | | | |

| Hydronic Radiant/Wallfin Heater | | | | | |
|---|---|---|---|---|---|
| **Point Name** | **Hardware Points** | | | | **Keynotes** |
| | **AI** | **AO** | **BI** | **BO** | |
| Zone Temperature | x | | | | TE200AS12 stainless steel wallplate or equivalent. |
| Perimeter Heating Valve Output | | x | | | |
| **General Notes** | | | | | |
| EB-133 (WM05) Male Washroom: Mechanical contractor to install new control valve supplied by controls contractor. VG1000 series or equivalent in rooms. Controls contractor to install new sensor and wire to nearest BACnet controller. | | | | | |
| EB-135 (WF05) Female Washroom: Mechanical contractor to install new control valve supplied by controls contractor. VG1000 series or equivalent in rooms. Controls contractor to install new sensor and wire to nearest BACnet controller. | | | | | |
| EB-208 (WM01) Male Washroom: Control valve to be re-used. Sensor replacement only. | | | | | |
| B-210 (WF01) Female Washroom: Control valve to be re-used. Sensor replacement only. | | | | | |

| Bypass Damper | | | | | |
|---|---|---|---|---|---|
| **Point Name** | **Hardware Points** | | | | **Keynotes** |
| | **AI** | **AO** | **BI** | **BO** | |
| Zone Temperature | x | | | | |
| Bypass Damper Output | | x | | | |
| **General Notes** | | | | | |
| BACnet TEC to remain | | | | | |

| Hydronic/Electric Force Flow Heater | | | | | |
|---|---|---|---|---|---|
| **Point Name** | **Hardware Points** | | | | **Keynotes** |
| | **AI** | **AO** | **BI** | **BO** | |
| Zone Temperature | x | | | | TE200AS12 stainless steel wallplate or equivalent. |
| Forced Flow Heater Command | | | | x | |
| Forced Flow Heater Amps | x | | | | Analog current sensor |
| **General Notes** | | | | | |
| All points are new. | | | | | |

| Hydronic/Electric Unit Heater | | | | | |
|---|---|---|---|---|---|
| **Point Name** | **Hardware Points** | | | | **Keynotes** |
| | **AI** | **AO** | **BI** | **BO** | |
| Zone Temperature | x | | | | TE200AS12 stainless steel wallplate or equivalent. |
| Heater Command | | | | x | |
| Heater Amps | x | | | | Analog current sensor |
| **General Notes** | | | | | |
| All points are new. | | | | | |

| Vent Damper with Hydronic Unit Heater | | | | | |
|---|---|---|---|---|---|
| **Point Name** | **Hardware Points** | | | | **Keynotes** |
| | **AI** | **AO** | **BI** | **BO** | |
| Zone Temperature | x | | | | Replace with TE200AS12 stainless steel wallplate or equivalent. |
| Vent Damper Command | | | | x | |
| Unit Heater Command | | | | x | |
| Unit Heater Amps | x | | | | New point. Analog current sensor |
| **General Notes** | | | | | |
| Points are existing unless otherwise specified. | | | | | |
| Control wiring can be re-used if not part of communication trunk. | | | | | |
| Controller power to be re-used. | | | | | |

| Exhaust Fan with Hydronic/Electric Force Flow Heater | | | | | |
|---|---|---|---|---|---|
| **Point Name** | **Hardware Points** | | | | **Keynotes** |
| | **AI** | **AO** | **BI** | **BO** | |
| Zone Temperature | x | | | | TE200AS12 stainless steel wallplate or equivalent. |
| Heater Command | | | | x | |
| Heater Amps | x | | | | Analog current sensor |
| Exhaust Fan Command | | | | x | |
| Exhaust Fan Amps | x | | | | Analog current sensor |
| **General Notes** | | | | | |
| All points are new. | | | | | |

| Exhaust Fan with Hydronic/Electric Unit Heater | | | | | |
|---|---|---|---|---|---|
| **Point Name** | **Hardware Points** | | | | **Keynotes** |
| | **AI** | **AO** | **BI** | **BO** | |
| Zone Temperature | x | | | | TE200AS12 stainless steel wallplate or equivalent. |
| Heater Command | | | | x | |
| Heater Amps | x | | | | Analog current sensor |
| Exhaust Fan Command | | | | x | |
| Exhaust Fan Amps | x | | | | Analog current sensor |
| **General Notes** | | | | | |
| All points are new. | | | | | |

| Exhaust Fan - Temperature Control | | | | | |
|---|---|---|---|---|---|
| **Point Name** | **Hardware Points** | | | | **Keynotes** |
| | **AI** | **AO** | **BI** | **BO** | |
| Zone Temperature | x | | | | TE200AS12 stainless steel wallplate or equivalent. |
| Exhaust Fan Command/Enable | | | | x | |
| Exhaust Fan Amps | x | | | | Analog current sensor |
| **General Notes** | | | | | |
| All points are new. | | | | | |

| EF-71 and SF-01 – Finishing Room | | | | | |
|---|---|---|---|---|---|
| **Point Name** | **Hardware Points** | | | | **Keynotes** |
| | **AI** | **AO** | **BI** | **BO** | |
| Exhaust Fan Enable | | | | x | |
| Exhaust Fan Amps | x | | | | Analog current sensor |
| Supply Fan Command | | | | x | |
| Supply Fan Amps | x | | | | Analog current sensor |
| **General Notes** | | | | | |
| All points are new. | | | | | |

| Exhaust Fan - Enable with OA damper control. EB-131 Recyling Room | | | | | |
|---|---|---|---|---|---|
| **Point Name** | **Hardware Points** | | | | **Keynotes** |
| | **AI** | **AO** | **BI** | **BO** | |
| Exhaust Fan Enable | | | | x | |
| Exhaust Fan Amps | x | | | | |
| Outdoor Air Damper | | | | x | |
| **General Notes** | | | | | |
| All points are new. | | | | | |

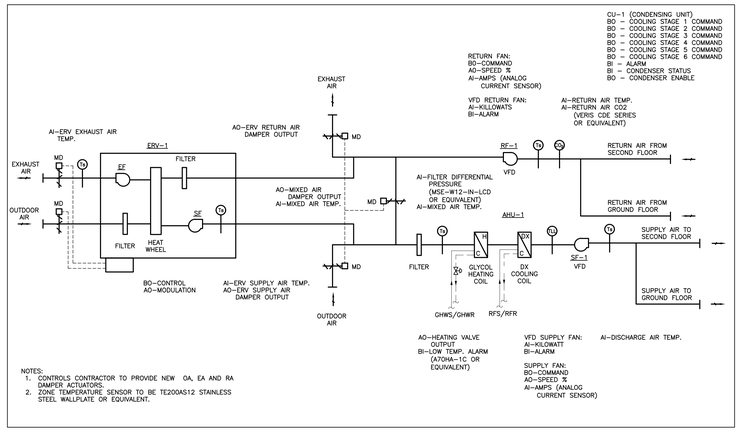
| Exhaust Fan - On/Off or Enable/Disable | | | | | |
|---|---|---|---|---|---|
| **Point Name** | **Hardware Points** | | | | **Keynotes** |
| | **AI** | **AO** | **BI** | **BO** | |
| Exhaust Fan Command/Enable | | | | x | |
| Exhaust Fan Amps | x | | | | |
| **General Notes** | | | | | |
| All points are new. | | | | | |

| Corridor Lighting | | | | | |
|---|---|---|---|---|---|
| **Point Name** | **Hardware Points** | | | | **Keynotes** |
| | **AI** | **AO** | **BI** | **BO** | |
| Security System Armed Status | | | x | | Tie into security panel relay with nearest BAS controller |
| Security System Intruder Alarm Status | | | x | | Tie into security panel relay with nearest BAS controller |
| Fire Alarm Status | | | x | | Tie into security panel relay with nearest BAS controller |
| Corridor Lighting 1 Command | | | | x | Time clock in EB-131B (EL02) Electrical Room to be replaced with Hand/Off/Auto switch and tied into BAS. |
| Corridor Lighting 2 Command | | | | x | Time clock in EB-153 (S008) Storage Room to be replaced with Hand/Off/Auto switch and tied into BAS. |
| **General Notes** | | | | | |
| All points are new. Coordinate with DCDSB security system contractor. | | | | | |

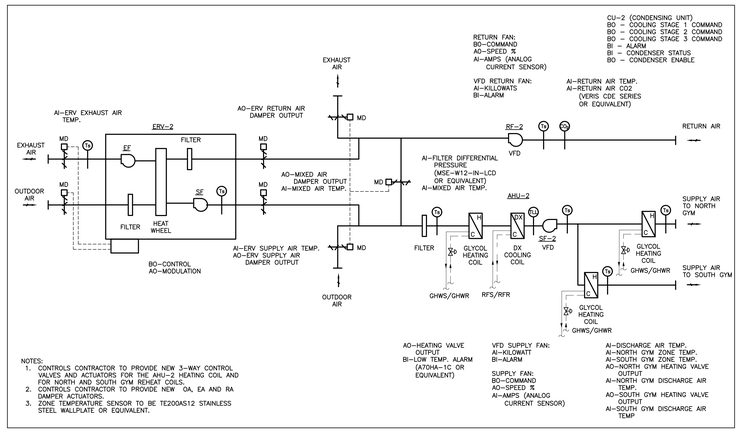
| Outdoor Lighting | | | | | |
|---|---|---|---|---|---|
| Point Name | Hardware | | | | Keynotes |
| | AI | AO | BI | BO | |
| Outdoor Lighting Command | | | | x | Time clock in EB-131B (EL02) Electrical Room to be replaced with Hand/Off/Auto switch and tied into BAS. |
| General Notes | | | | | |
| All points are new. | | | | | |

| Domestic Hot Water System | | | | | |
|---|---|---|---|---|---|
| **Point Name** | **Hardware Points** | | | | **Keynotes** |
| | **AI** | **AO** | **BI** | **BO** | |
| Domestic Hot Water Temperature | x | | | | New. Strap on sensor |
| Domestic Hot Water Pump Command | | | | x | |
| Domestic Hot Water Pump Amps | x | | | | New . Analog current sensor |
| **General Notes** | | | | | |
| Points are existing unless otherwise specified. | | | | | |
| Control wiring can be re-used if not part of communication trunk. | | | | | |
| Controller power to be re-used. | | | | | |

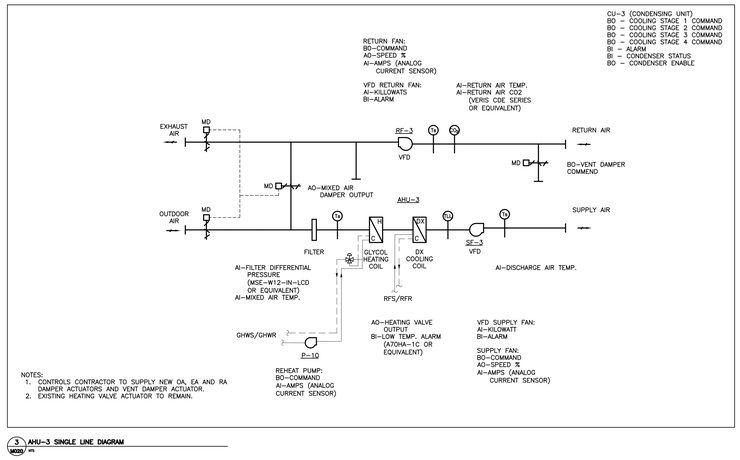
| Energy | | |
|---|---|---|
| **Point Name** | **Point Type** | **Keynotes** |
| Electricity Demand | Pulse | Existing Electric meter to be tied into nearest BAS controller |
| Natural Gas Demand | Pulse | Existing Natural meter to be tied into nearest BAS controller |
| **General Notes** | | |
| All points are new. | | |
| Electric pulse meter to be disconnected from existing Carma meter and wired to nearest BAS controller. Controls contractor to commission. | | |
| Natural gas pulse meter to be disconnected from existing Carma meter and wired to nearest BAS controller. Controls contractor to commission. | | |



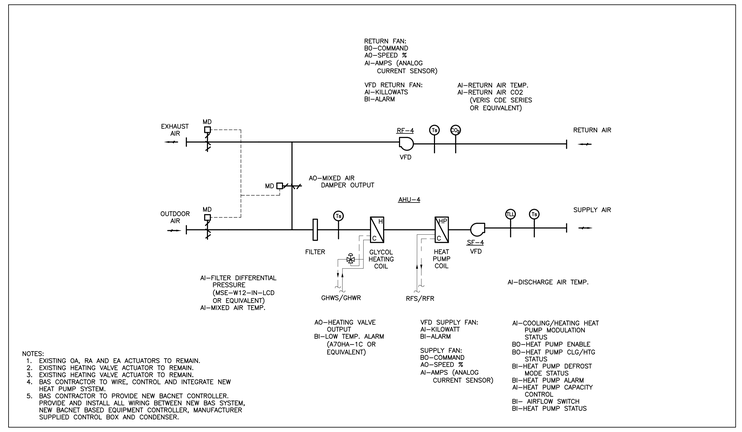

1 AHU–1 SINGLE LINE DIAGRAM
M020/ NTS



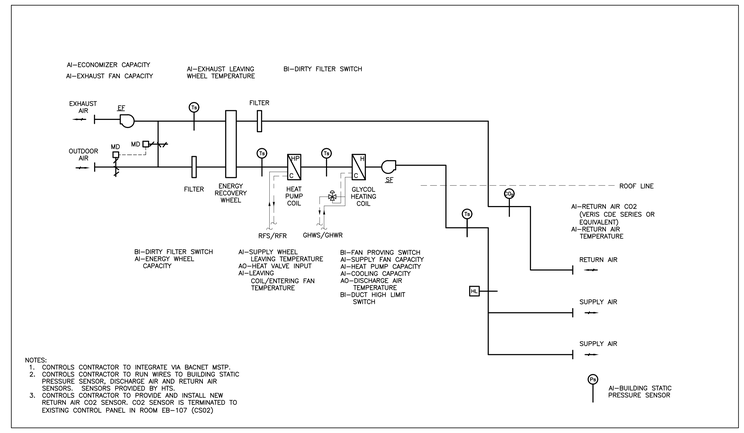

2 AHU–2 SINGLE LINE DIAGRAM
M020/ NTS



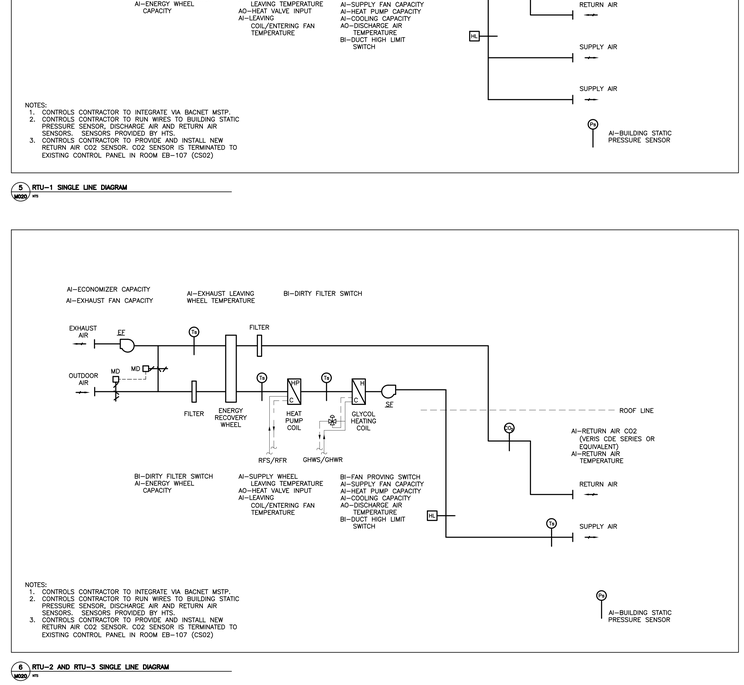

3 AHU–3 SINGLE LINE DIAGRAM
M020/ NTS



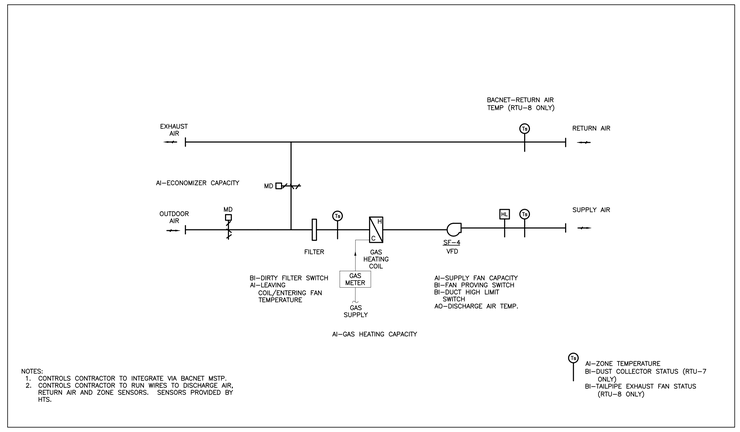

4 AHU–4 SINGLE LINE DIAGRAM
M020/ NTS



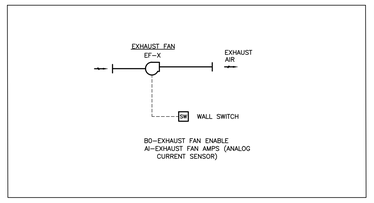

5 RTU–1 SINGLE LINE DIAGRAM
M020/ NTS



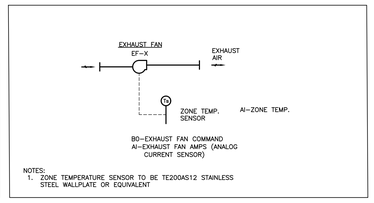

6 RTU–2 AND RTU–3 SINGLE LINE DIAGRAM
M020/ NTS



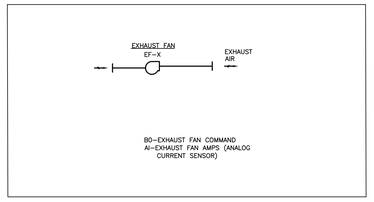

7 RTU–7 AND RTU–8 SINGLE LINE DIAGRAM
M020/ NTS



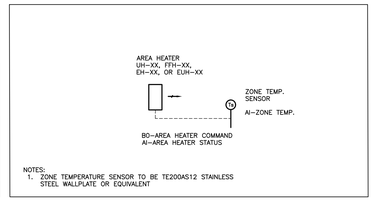

7 TYPICAL MANUAL STARTER EXHAUST FAN SINGLE LINE DIAGRAM
M020/ NTS



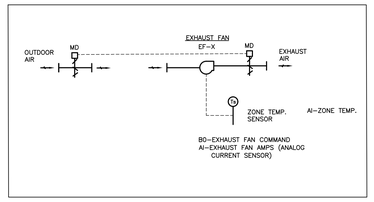

9 TYPICAL TEMPERATURE CONTROLLED EXHAUST FAN SINGLE LINE DIAGRAM
M020/ NTS



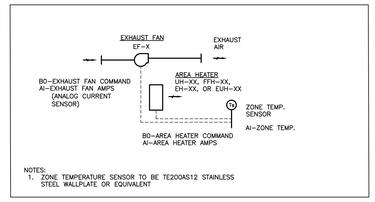

8 TYPICAL STARTER EXHAUST FAN SINGLE LINE DIAGRAM
M020/ NTS



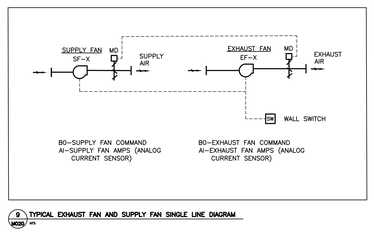

10 TYPICAL AREA HEATER SINGLE LINE DIAGRAM
M020/ NTS



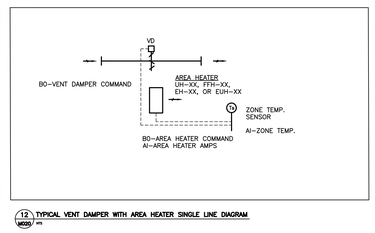

8 TYPICAL BAS CONTROLLED EXHAUST FAN SINGLE LINE DIAGRAM
M020/ NTS




11 TYPICAL AREA HEATER SINGLE LINE DIAGRAM
M020/ NTS




9 TYPICAL EXHAUST FAN AND SUPPLY FAN SINGLE LINE DIAGRAM
M020/ NTS




12 TYPICAL VENT DAMPER WITH AREA HEATER SINGLE LINE DIAGRAM
M020/ NTS

BAS SCOPE OF WORK:

1. CONVERT EXISTING N2 SYSTEM TO BACNET MSTP.
2. REWIRE BAS (COMMUNICATION) TRUNKS.
3. REPLACE ALL CONTROLLERS, SENSORS, SUPERVISORY HARDWARE. REPLACE ALL CONTROLLERS, SENSORS, TEMPERATURE LOW LIMIT DEVICES AND SUPERVISORY HARDWARE.
4. IMPLEMENT REVISE SEQUENCES AS PER SPECIFICATIONS.
5. UPDATE SYSTEM GRAPHICS, FLOOR PLANS, AND USER INTERFACE AS PER SPECIFICATIONS.
6. BAS FLOOR PLAN GRAPHICS TO BE BROKEN DOWN INTO KEY PLANS TO MATCH MECHANICAL DRAWINGS.
7. DEMOLISH ALL REDUNDANT BAS CONTROLLERS.
8. DEMOLISH ALL REDUNDANT SENSORS.
9. EXISTING CONTROL POWER AND WIRING CAN BE RE–USED.
10. LABEL ALL CONTROLLERS.
11. LABEL ALL CONTROL PANELS.
12. LABEL CEILING TILE GIRD WHERE CONTROLLERS ARE ABOVE CEILING.
13. PROVIDE FLOOR PLANS WITH CONTROLLER LOCATIONS.
14. PROVIDE BAS AS–BUILTS OF NEW AND EXISTING EQUIPMENT.
15. CONTROL CABINETS TO BE RE–USED UNLESS OTHERWISE SPECIFIED.
16. EXISTING AND NEW WIRING TO BE LABELED.
17. BAS CONTRACTOR TO COORDINATE WITH EQUIPMENT SUPPLIER TO VERIFY ALL MANUFACTURER SUPPLIED SENSORS AND SWITCHES. ANY ADDITIONAL SENSORS, SWITCHED, ANALOG, DIGITAL OR SOFTWARE VALUES REQUIRED TO OPERATE OUTLINED SEQUENCE OF OPERATION SHALL BE PROVIDED AT NO ADDITIONAL COSTS.

APPROVED VENDORS ARE JOHNSON CONTROLS METASYS AND CARRIER/AUTOMATED LOGIC WEBCTRL

CONTACTS:

JOHNSON CONTROLS
TEGAN DIETSCH
TEGAN.DIETSCH@JCI.COM

CARRIER/AUTOMATED LOGIC
WAJIHA AKBAR
WAJIHA.AKBAR@CARRIER.COM

PROJECT OWNER

**DURHAM CATHOLIC DISTRICT SCHOOL BOARD**
*Learning and Living in Faith*

REVISIONS/SUBMISSIONS

| No. | DATE | DESCRIPTION |
|---|---|---|
| 1 | 2026-04-16 | ISSUED FOR TENDER |
| 2 | 2026-04-21 | ISSUED FOR PERMIT |
| 3 | 2026-05-05 | ISSUED FOR ADDENDUM 3 |

PROJECT NORTH | TRUE NORTH

rybka Ellard Willson
23 Lesmill Road, Unit 410
Toronto, ON M3B 3P6

Project Title

ARCHBISHOP DENIS O'CONNOR MECHANICAL UPGRADES

80 MANDRAKE ST.
AJAX ON. L1S 5H4

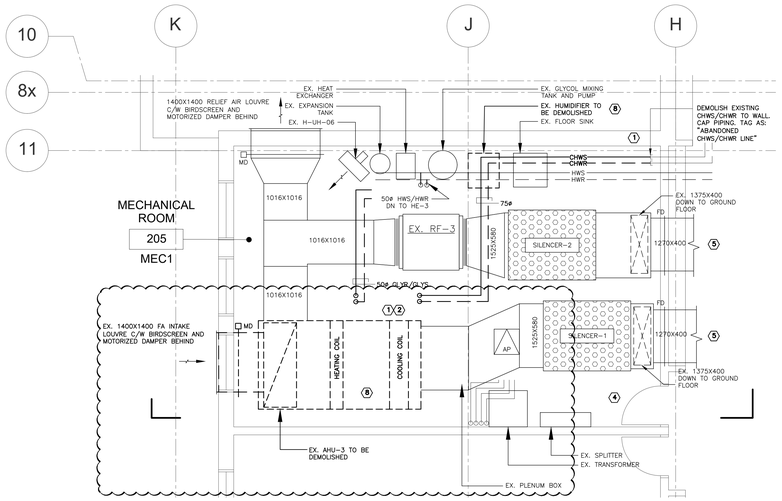
Sheet Title

MECHANICAL CONTROLS

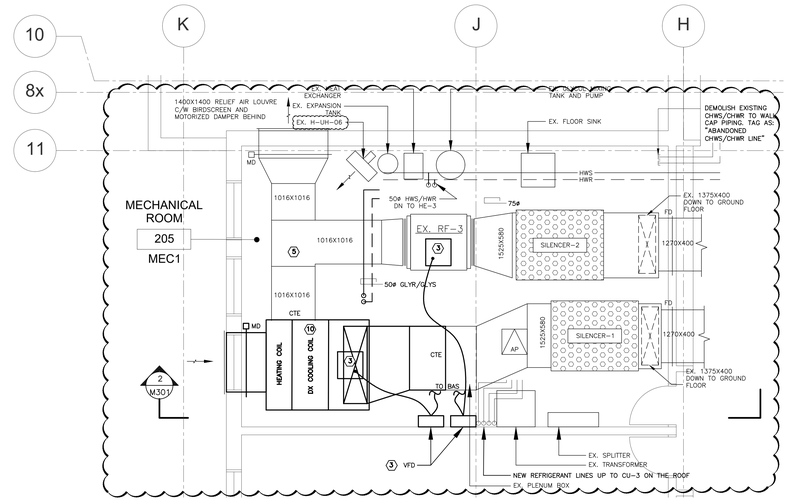
| | |
|---|---|
| Project Number | 25119 |
| Date | APR. 2026 |
| Drawn | M.Z |
| Checked | R.S |
| Scale | NTS |

Drawing Number

M-020



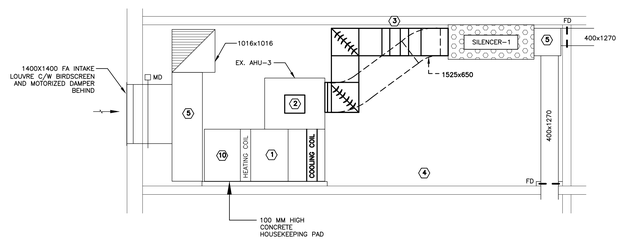

1 M301 MECHANICAL ROOM 205 (AHU-3) DEMOLITION LAYOUT
1:50



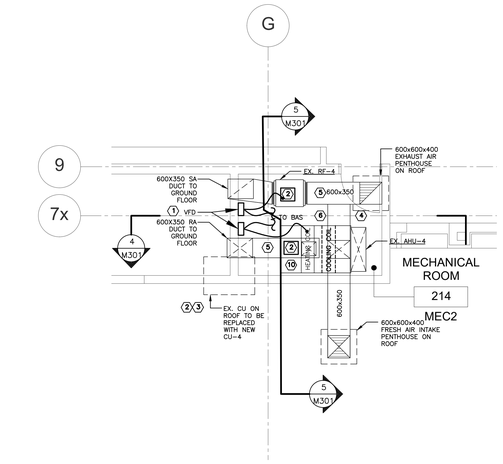

2 M301 MECHANICAL ROOM 205 (AHU-3) NEW LAYOUT
1:50

DEMOLITION AND CONSTRUCTION NOTES:

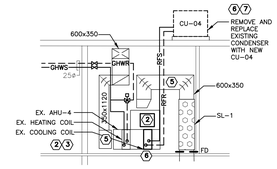
1. REMOVE EXISTING AHU-3 AND ALL ASSOCIATED VALVES AND ASSOCIATED ACCESSORIES.
2. CUT BACK CHILLED WATER LINES WHERE SHOWN. CAP AND LABEL PIPES AS ABANDONED CHILLED WATER LINES.
3. CONTRACTOR TO INSTALL NEW VFDS FOR AHU-3 SUPPLY AND RETURN FANS. CONTRACTOR TO REPLACE FAN MOTORS WITH EQUIVALENT PERFORMANCE AND INTEGRATION TO VFD'S. CONTRACTOR TO COORDINATE NEW MOTORS WITH NEW VFD'S. VFD'S TO BE TIED INTO BAS.
4. PAINT FLOOR WITH GREY ANTISLIP FLOOR PAINT (SHINY) WITH YELLOW CAUTION PAINT OUTLINING CURBS. TYPICAL FOR ALL MECHANICAL ROOMS WITH AIR HANDLING UNITS.
5. CONTRACTOR TO PROVIDE DUCT CLEANING FOR ALL EXISTING DUCTWORK.
6. REMOVE EXISTING SPLIT DX COIL FROM EXISTING AHU, WITH ALL REFRIGERANT PIPING AND ROOF MOUNTED CONDENSING UNIT.
7. INSTALL NEW SPLIT DX COIL IN THE EXISTING AHU COMPLETE WITH NEW REFRIGERANT PIPING AND CONDENSING UNIT ON THE ROOF. INSTALL UNIT ON SLEEPS. REFER TO STRUCTURAL DRAWINGS FOR DETAILS.
8. EXISTING HUMIDIFIER TO BE DEMOLISHED, INCLUDING ASSOCIATED COIL IN DUCTWORK AND DISPERSION TUBES.
9. REMOVE EXISTING CHILLER AND COOLING TOWER AND ALL ASSOCIATED PUMPS, VALVES, PIPING AND ACCESSORIES.
10. CONTRACTOR TO REPLACE ALL EXISTING SENSORS WITH NEW FOR ALL AHUs. TO BE TIED INTO BAS SYSTEM.
11. REPLACE ALL CURRENT SWITCHES WITH ANALOG CURRENT TRANSDUCERS FOR ALL SYSTEMS. CONTRACTOR TO LOCATE AND REPLACE ALL THROUGHOUT BUILDING.
12. INSTALL NEW OCCUPANCY SENSING SENSORS FOR ALL ZONES.
13. CLOSE UP CHILLER OPENINGS IN THE OUTDOOR WALLS AND ROOF. WALL TO BE INSTALLED WITH INSULATED METAL PANELS, FINISHED WITH ALUMINUM SHEETING ON BOTH INTERIOR AND EXTERIOR AND HAVE AN ASSEMBLED R-20 THERMAL INSULATION VALUE. WALL TO BE WATER TIGHT AND MECHANICALLY FASTENED TO EXISTING STRUCTURE. ROOF OPENING TO BE ENCLOSED WITH INSULATED ALUMINUM SHEET METAL PANELS AND INSTALLED ON AN ANGLE FOR NO STANDING WATER. PANELS ARE TO BE INSULATED WITH AN ASSEMBLE OF R-30 THERMAL INSULATION VALUE.



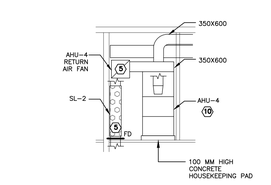

3 M301 MECHANICAL ROOM 205 (AHU-3) DEMOLITION SECTION VIEW
1:50



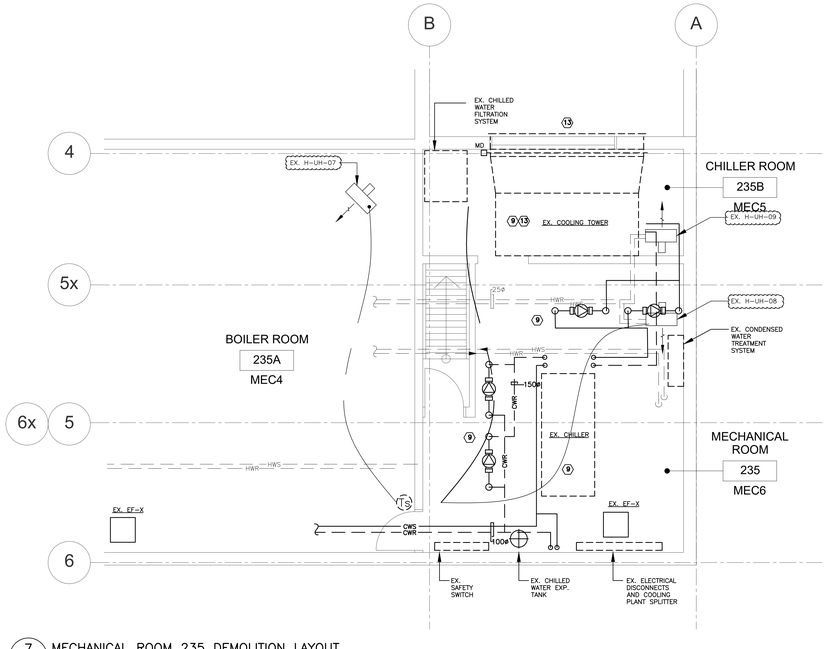

4 M301 MECHANICAL ROOM 214 (AHU-4) DEMOLITION LAYOUT
1:50



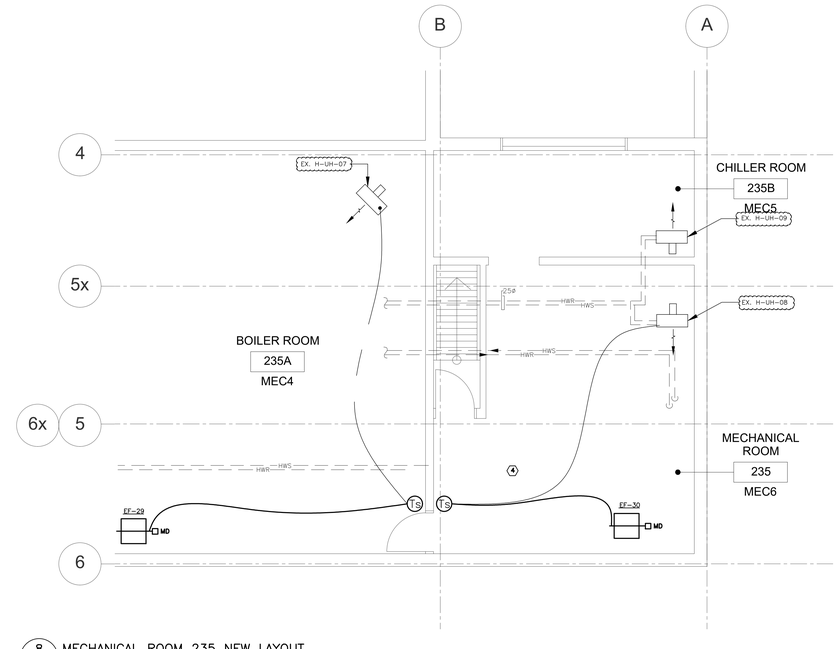

5 M301 MECHANICAL ROOM 214 (AHU-4) DEMOLITION SECTION VIEW
1:50




6 M301 MECHANICAL ROOM 214 (AHU-4) DEMOLITION SECTION VIEW
1:50




7 M301 MECHANICAL ROOM 235 DEMOLITION LAYOUT
1:50




8 M301 MECHANICAL ROOM 235 NEW LAYOUT
1:50

PROJECT OWNER

DURHAM CATHOLIC DISTRICT SCHOOL BOARD
*Learning and Living in Faith*

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Toronto, ON M3B 3P6

Project Title

ARCHBISHOP DENIS O'CONNOR MECHANICAL UPGRADES

80 MANDRAKE ST.
AJAX ON. L1S 5H4

Sheet Title

MECHANICAL
SECOND FLOOR
MECHANICAL ROOMS
205, 214, 235, 235A, 235B

| | |
|---|---|
| Project Number | 25119 |
| Date | APR. 2026 |
| Drawn | M.Z |
| Checked | R.S |
| Scale | 1:100 |

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