Division 25 | Integrated Automation Systems

Section includes various guidelines for the design of Integrated Automation Systems, common work results, system commissioning and equipment.

This design guideline is written to the designer of record (DOR). This guideline is written to document UA standards of work, assist the designers in ensuring UA standards are incorporated into the contract documents, and provide a resource to facilitate the design process. It is the DOR's responsibility to coordinate the criteria set forth in design guideline and in conjunction with the manufacturer requirements and use the most stringent standard.

This guideline is not intended to include all requirements necessary for the design of automation systems but to indicate University preferences where they exist. Input from the DOR is encouraged when new practices, products, or systems are available which may increase the value of the installed automation systems but may be in conflict with these guidelines. Any such recommendations may be presented to the Campus Development architectural and engineering staff during project design phase.

Section 25 01 00 – Design of Integrated Automation Systems

A. Codes and Standards

1. Codes and Standards: The University of Alabama falls under the jurisdiction of the State of Alabama Division of Construction Management. The codes and standards currently adopted and enforced by the Division of Construction Management as the State Building Code are available at http://dcm.alabama.gov/bldg_code.aspx with permitted exceptions. Note that the body of codes adopted and enforced include standards used as reference standards within the codes listed.

2. Where specific/specialized systems and/or installations are not covered by these standards or referenced codes, designer shall reference and specify adherence to industry standard codes and apply best engineering practices applicable to these specific systems or installations. Designer shall identify codes/standards used for design of these specialized systems on the mechanical drawings.

B. Integrated Automation System Overview

1. From the introduction of direct digital controls on the University of Alabama campus in the mid 1990's until recently, the University has standardized on the Schneider Electric lineage of products (Barber Coleman, Siebe, TAC/Invensys and eventually Schneider Electric) to provide building automation for campus and off-campus facilities. The controllers are configured in a Field Device, Field Equipment Controller, Building Level Controller to Virtual Machine Enterprise Level Supervisor system architecture with Field Equipment to Building Level Controllers communicating over either a proprietary ASD or LON communications bus. Communications from Building Level Controllers to Enterprise Level Supervisors occurs through the University LAN.

2. With the discontinuation of Schneider Electric LON based controller production in the middle of 2022, the University of Alabama is migrating to a BACnet/IP Field Equipment to Building Level Controller communications architecture. The control product platform is also being migrated from Schneider Electric LON based equipment to Distech Eclypse BACnet/IP based equipment. System architecture shall remain in a Field Device, Field Equipment Controller, Building Level Controller to Virtual Machine Enterprise Level Supervisor configuration.

3. Designers should note the use of "Integrated Automation Systems" within these design guidelines. As the University looks to provide more cohesively controlled and energy efficient buildings, additional systems beyond HVAC such as Lighting Controls, Plumbing Automation and other systems will be added to this section.

C. Design for Future Growth/Spare Capacity

1. Prior to start of design obtain requirements for future growth from UA project manager. If future growth of the facility is expected, either provide supplemental system capacity at initial installation to support facility expansion or provide the ability to add future system capacity to the infrastructure provided at initial installation. Future installation of additional capacity and/or connection of additional load/systems shall not require any significant demolition of building elements or mechanical systems.

D. Design Review of Existing Conditions/Capacities

1. In addition to review of existing design drawings – field verify existing conditions. Do not assume that existing record drawings are complete or accurate, if discrepancies between record drawings and existing conditions are found during design surveys and/or during construction notify the owner immediately.

2. Field verify condition of existing equipment and existence of any previously designed spare capacity prior to design. Do not assume that existing equipment is identical to equipment originally designed. Do not assume that existing equipment is operating at original design capacity.

E. Design Requirements – Maintenance Accessibility

1. Locate equipment requiring maintenance so that it is easily accessible primarily in mechanical rooms. Avoid installations that require the use of lifts or scaffolding, or the removal of other equipment for routine maintenance.

F. Cost Estimating/Project Budget

1. Cost Estimating shall be performed as required in the Owner/Designer Agreement.

G. Manufacturers

1. The engineer shall use the manufacturers listed in these design guidelines to select equipment and develop construction specifications.

H. Equipment Provided by Owner

1. Where owner desires to purchase specific equipment due to timing and or cost considerations, designer shall be responsible for providing documentation necessary for purchasing including specifications, drawings and details (as applicable). Designer shall also provide assistance and technical support during the purchasing process as needed.

2. Design must reflect actual equipment purchased by the owner. Include submittal data of actual equipment purchased as part of contract documents.

3. Design documents shall instruct the contractor to manage all aspects of equipment receipt, including coordination with the supplier, unloading, storage/relocation as needed. Provide equipment protection as necessary.

I. Demolition Requirements

1. To maximum extent feasible, remove abandoned automation/controls equipment, tubing, piping and cabling.

2. The A/E must caution the Contractor that all shutdowns of systems serving occupied spaces outside the area of this project shall be absolutely minimized.

J. Bid/Construction Drawing Requirements

1. Prepare Division 25, Integrated Automation System, Specifications. Include the following sections as applicable to the project, See "UA Integrated Automation System Guideline Specifications." Sections include the following:

    a. Section 25 05 01, Integrated Automation System General Requirements
    b. Section 25 05 02, Integrated Automation System Submittals
    c. Section 25 05 03, Integrated Automation System Project Record Documents
    d. Section 25 05 04, Integrated Automation System Start-Up, Verification and Commissioning
    e. Section 25 05 05, Integrated Automation System Training
    f. Section 25 10 01, Integrated Automation System Networks
    g. Section 25 10 02, Integrated Automation System Computer Systems, MMI
    h. Section 25 30 01, Integrated Automation System Field Controllers
    i. Section 25 35 13, Integrated Automation System Actuators and Operators
    j. Section 25 35 16, Integrated Automation System Sensors and Transmitters
    k. Section 25 35 19, Integrated Automation System Control Valves
    l. Section 25 35 27, Integrated Automation System Variable Frequency Drives
    m. Section 25 35 30, Integrated Automation System Tubing, Cabling and Raceway

2. Prepare the following Integrated Automation System drawings (as applicable to the project):

    a. Integrated Automation System Architecture Drawings

        1) System Architecture Drawings to include overview of project scope showing network connectivity configuration of Integrated Automation System.

        2) System Architecture Diagram to include physical network locations of Building Operations Server, Network Aggregation and Operations Switches, Network Controller and all BACnet/IP connected devices.

        3) Provide phasing notes on diagram, where applicable.

        4) See Integrated Automation System Design Guideline Drawing DG-SD1 for example.

    b. Integrated Automation System Architecture Demolition Plans

        1) Where applicable, provide System Architecture diagram of existing automation networks. Identify existing systems to remain and existing systems to be removed/demolished.

2) Plans to identify equipment to be turned over to owner following demolition. Note on plans that owner has first right of refusal for all existing automation equipment in addition to identified items.

c. Integrated Automation System Floor Plans

1) Show locations of all devices shown on system architecture diagrams including Building Operations Server, Network Aggregation and Operations Switches, Network Controller and all BACnet/IP connected devices.

2) Show locations of equipment requiring controls connections located remotely from controllers.

3) Provide reference callouts to specific equipment assemblies, coordinate with electrical, IT and fire alarm disciplines to provide electrical power, fire alarm and telecommunications connections and to coordinate installation/clearance requirements.

4) See Integrated Automation System Design Guideline Drawing DG-SD2 for example.

d. Integrated Automation System Network Device/Controller Schematics

1) Provide details for network control devices including enclosures, mounting details and cable interconnection requirements.

2) Indicate on details locations of owner furnished equipment.

3) Provide information regarding Building Operations Server programming/configuration requirements.

4) See Integrated Automation System Design Guideline Drawing DG-SD3 for example.

e. Equipment/System Specific Schematics

1) Provide System Schematic showing equipment and all controlled devices/points.

2) Provide Sequence of Operations.

3) Provide details for control device installation including enclosures, mounting details and cable interconnection requirements.

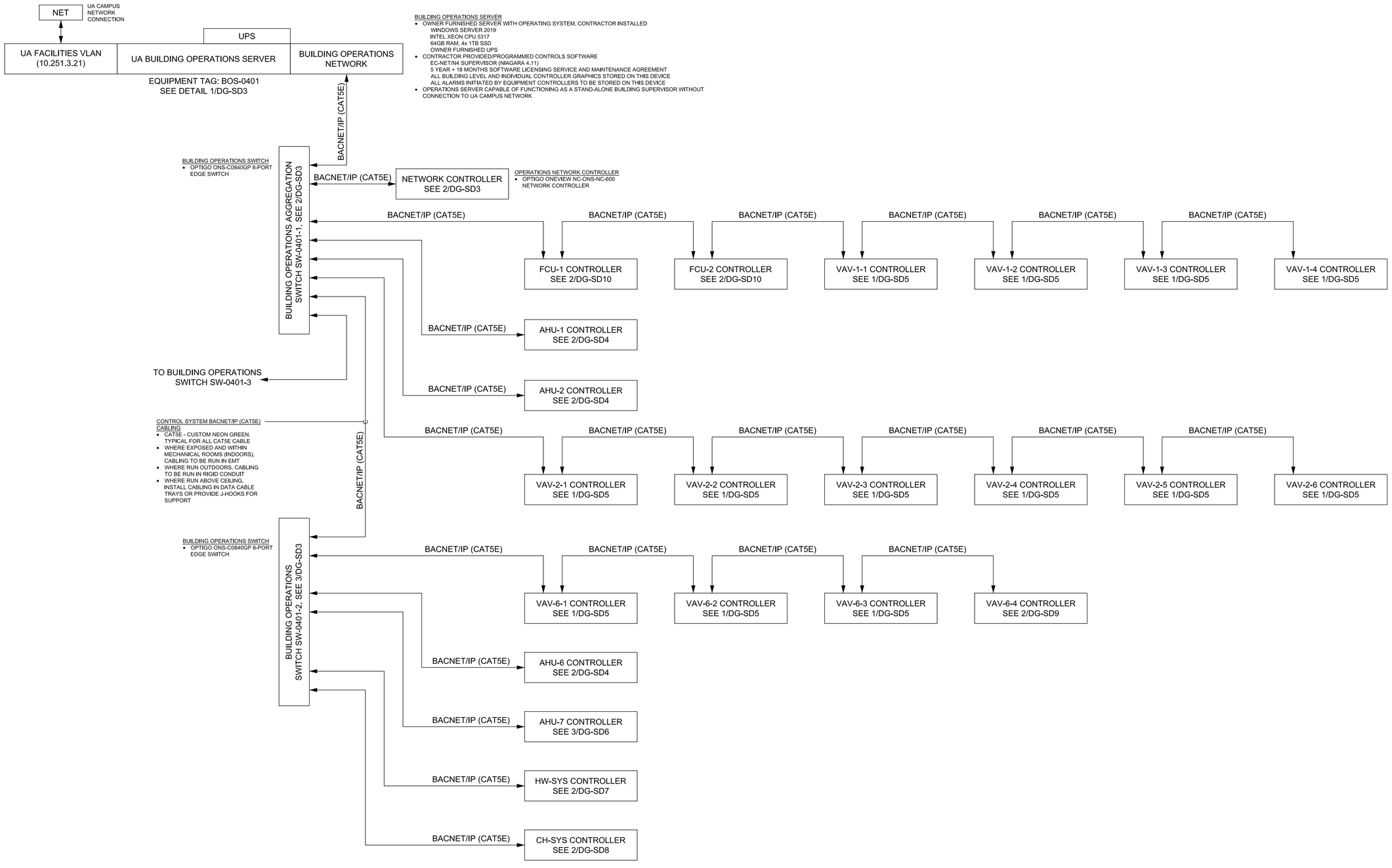
4) Indicate on details locations of owner furnished equipment.

5) See Integrated Automation System Design Guideline Drawings DG-SD4 through DG-SD9 for examples.

6) Contact UA project manager for additional information/guidance and additional example documents.

Change Log – 25 01 00

Description of Change	Sheet or Drawing	Date
Created new section v1.0	250100	10/2022



UA FACILITIES AUTOMATION CONTROLS DESIGN GUIDELINES

Project Title:

THE UNIVERSITY OF ALABAMA
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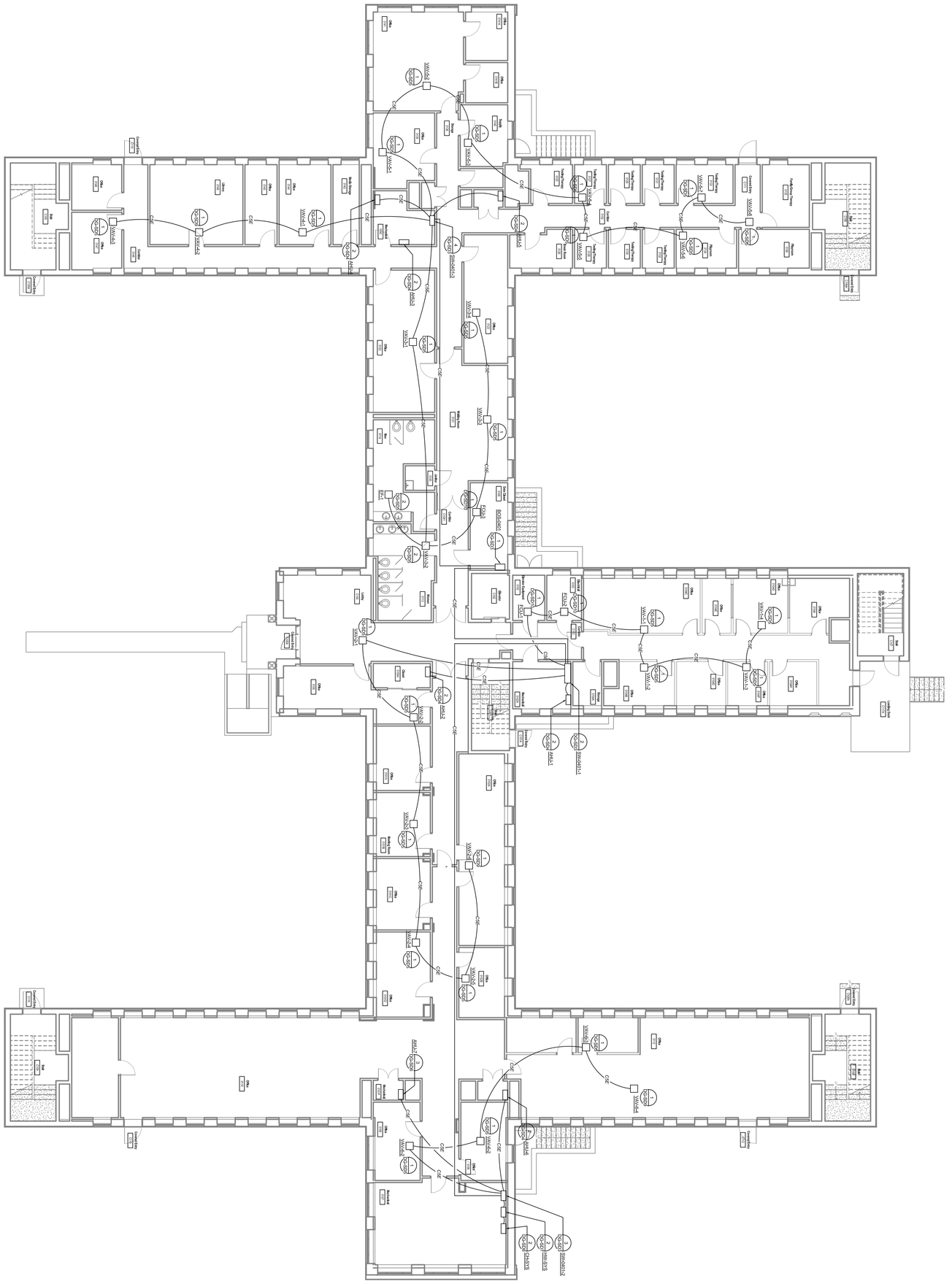
designed:		checked:	
drawn:	SCC	date:	7/12/2022

rev	description	date	checked
1.2	GEN. REV	09.06.22	
1.3	GEN. REV	10.04.22	

Sheet Title:
DISTECH BACNET/IP (CAT5E) CONTROL SYSTEM (NEW CONSTRUCTION) EXAMPLE SYSTEM ARCHITECTURE DIAGRAM

Sheet No.
DG-SD1



designed:		checked:	
drawn:	SCC	date:	7/12/2022
rev	description	date	checked
1.2	GEN. REV.	09.06.22	
1.3	GEN. REV.	10.04.22	

Sheet Title:
DISTECH BACNET/IP (CAT5E) CONTROL SYSTEM (NEW CONSTRUCTION) DATA/LEVEL SYSTEM FLOOR PLAN AND CABLING DIAGRAM

Sheet No.
DG-SD2

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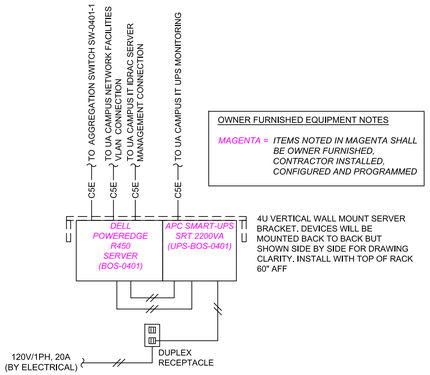
Project Title:

UA FACILITIES AUTOMATION CONTROLS DESIGN GUIDELINES



OWNER FURNISHED EQUIPMENT NOTES

MAGENTA = *ITEMS NOTED IN MAGENTA SHALL BE OWNER FURNISHED, CONTRACTOR INSTALLED, CONFIGURED AND PROGRAMMED*

BUILDING OPERATIONS SERVER NOTES

BUILDING OPERATIONS SERVER (BOS-0401) IS AN OWNER FURNISHED SERVER WITH WINDOWS SERVER 2019 AND CONFIGURED TO OPERATE IN THE UA IT ENVIRONMENT.

CONTRACTOR TO PROVIDE, PROGRAM AND CONFIGURE THE FOLLOWING SOFTWARE FOR INTEGRATION AND SUPERVISORY CONTROL OF ALL BUILDING SUBSYSTEMS:
- EC-NET/N4 SUPERVISOR (NIAGARA 4.11)
- 5 YEAR + 18 MONTHS SOFTWARE LICENSING SERVICE AND MAINTENANCE AGREEMENT

BUILDING LEVEL CONTROL FUNCTIONS REQUIRING COORDINATION OF OPERATIONS BETWEEN EQUIPMENT CONTROLLERS TO BE PERFORMED AT THE BUILDING OPERATIONS SERVER UNLESS NOTED OTHERWISE.

BUILDING LEVEL WEB-BASED GRAPHICAL USER INTERFACE TO RESIDE ON THE BUILDING OPERATIONS SERVER INCLUDE THE FOLLOWING:
- BUILDING MAIN PAGE WITH BUILDING PHOTO AND ALARM CONSOLE
- FLOOR PLANS FOR EACH LEVEL OF THE BUILDING WITH MAJOR EQUIPMENT LOCATIONS, EQUIPMENT SERVICE AREAS AND TEMPERATURE CONTROLLER/THERMOSTAT LOCATIONS
- INDIVIDUAL GRAPHICS PAGES FOR ALL EQUIPMENT AND SUBSYSTEMS (SEE INDIVIDUAL CONTROL SYSTEM SCHEMATICS)
- SUMMARY PAGES IN TABULAR FORMAT BY EQUIPMENT TYPE (AIR HANDLING UNITS, TERMINAL UNITS, ENERGY RECOVERY SYSTEM, EXHAUST FANS)
- OPERATING SCHEDULES FOR THE ALL EQUIPMENT WITH THE LISTED AVAILABLE OVERRIDE MODES:

  SINGLE ZONE AHU'S & FCU'S - OCCUPIED, STANDBY, UNOCCUPIED & SHUTDOWN MODES

  VAV TERMINAL UNITS - OCCUPIED, STANDBY & UNOCCUPIED

  MULTI-ZONE AHU'S - OCCUPIED, UNOCCUPIED & SHUTDOWN

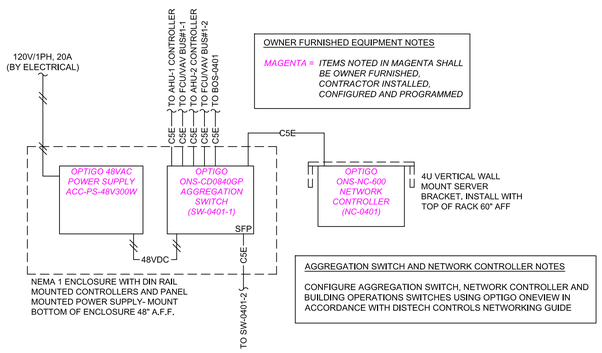
  CHILLED AND HEATING WATER SYSTEMS - SHUTDOWN MODE

BUILDING OPERATIONS SERVER TO GENERATE EMAIL NOTIFICATION FOR ALL ALARMS APPEARING ON ALARM CONSOLE. CONTROLS CONTRACTOR TO COORDINATE WITH UA FOR EMAIL ADDRESSES

BUILDING OPERATIONS SERVER TO STORE TREND DATA COLLECTED BY EQUIPMENT CONTROLLERS FOR ALL EQUIPMENT AS NOTED ON INDICATED ON EQUIPMENT CONTROL DIAGRAMS

1 DG-SD3 BUILDING OPERATIONS SERVER DETAIL

NOT TO SCALE
BOS-0401



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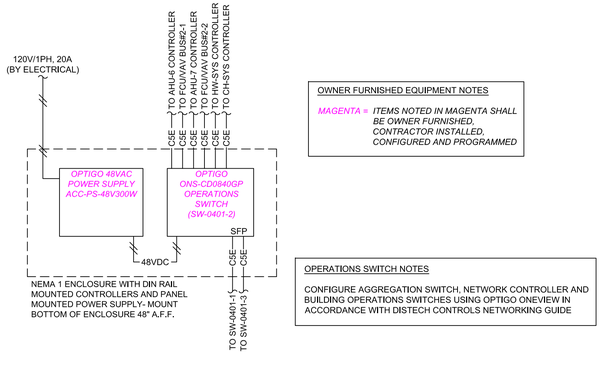
AGGREGATION SWITCH AND NETWORK CONTROLLER NOTES

CONFIGURE AGGREGATION SWITCH, NETWORK CONTROLLER AND BUILDING OPERATIONS SWITCHES USING OPTIGO ONEVIEW IN ACCORDANCE WITH DISTECH CONTROLS NETWORKING GUIDE

2 DG-SD3 AGGREGATION SWITCH/ NETWORK CONTROLLER DETAIL

NOT TO SCALE
SW-0401-1



OWNER FURNISHED EQUIPMENT NOTES

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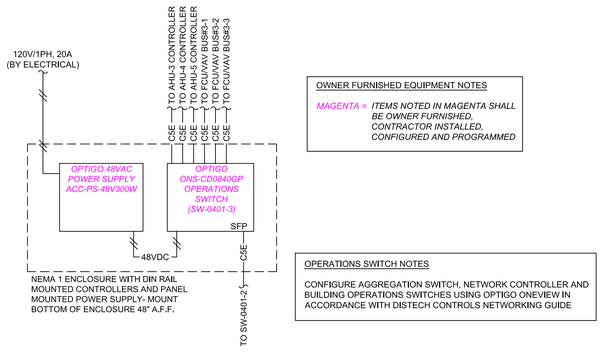
OPERATIONS SWITCH NOTES

CONFIGURE AGGREGATION SWITCH, NETWORK CONTROLLER AND BUILDING OPERATIONS SWITCHES USING OPTIGO ONEVIEW IN ACCORDANCE WITH DISTECH CONTROLS NETWORKING GUIDE

3 DG-SD3 OPERATIONS SWITCH DETAIL

NOT TO SCALE
SW-0401-2



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4 DG-SD3 OPERATIONS SWITCH DETAIL

NOT TO SCALE
SW-0401-3

THE UNIVERSITY OF ALABAMA 1831

UA FACILITIES AUTOMATION CONTROLS DESIGN GUIDELINES

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designed:		checked:	
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1.3	GEN. REV	10.04.22	

Sheet Title:
BACNET/IP CONTROL SYSTEM BUILDING OPERATIONS SERVER AND NETWORK DEVICE STANDARD DETAILS (NEW CONSTRUCTION)

Sheet No.
DG-SD3

PROGRAMMING & GRAPHICAL USER INTERFACE REQUIREMENTS

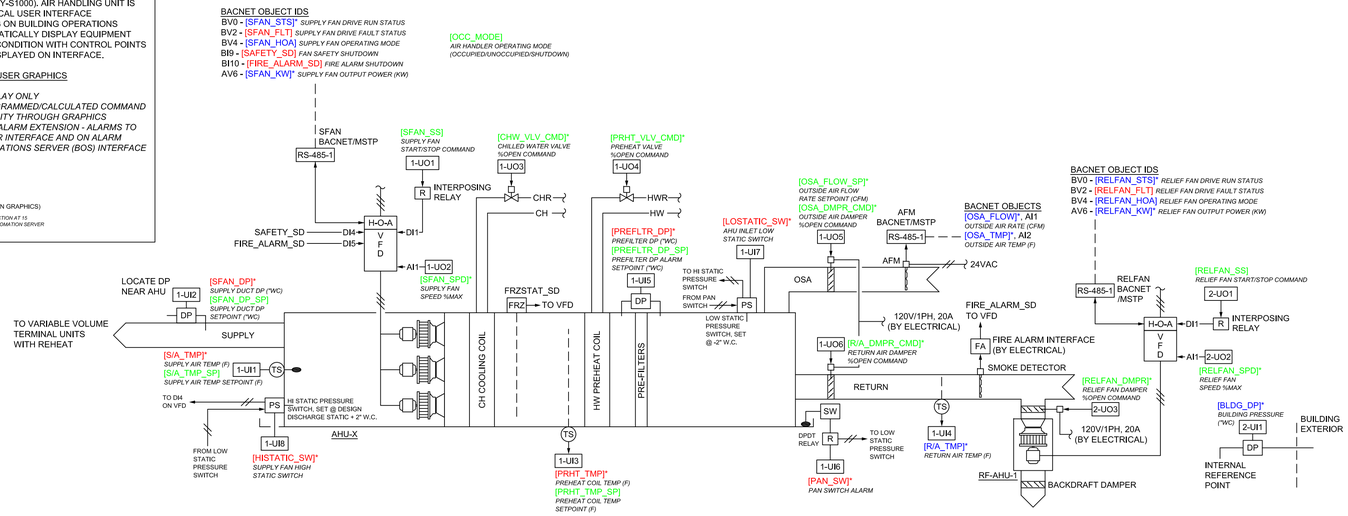
CONTROLS PROGRAMMING FOR EQUIPMENT SHOWN ON SCHEMATICS TO OCCUR AT EQUIPMENT CONTROLLER (ECY-S1000). AIR HANDLING UNIT IS TO BE PROVIDED WITH ITS OWN GRAPHICAL USER INTERFACE SCREEN/PAGE WITH GRAPHICS RESIDING ON BUILDING OPERATIONS SERVER (BOS). GRAPHICS TO DIAGRAMMATICALLY DISPLAY EQUIPMENT CONFIGURATION MATCHING INSTALLED CONDITION WITH CONTROL POINTS SHOWN IN THIS SCHEMATIC DIAGRAM DISPLAYED ON INTERFACE.

CONTROL POINTS TO BE DISPLAYED ON USER GRAPHICS

BLUE = *VALUESSTATUS POINTS DISPLAY ONLY*
GREEN = *CONTROL POINTS WITH PROGRAMMED/CALCULATED COMMAND VALUES & OVERRIDE CAPABILITY THROUGH GRAPHICS*
RED = *VALUE/STATUS POINTS WITH ALARM EXTENSION - ALARMS TO DISPLAY ON GRAPHICAL USER INTERFACE AND ON ALARM CONSOLE ON BUILDING OPERATIONS SERVER (BOS) INTERFACE*

CONTROL POINT LEGEND

[SFAN_SPD]* ——— POINT NAME
SUPPLY FAN SPEED ——— DISPLAY NAME (SHOWN ON GRAPHICS)
*ASTERISK INDICATES CONTROL POINT WITH TREND DATA COLLECTION AT 15 MINUTE INTERVALS - DATA STORAGE TO OCCUR AT BUILDING AUTOMATION SERVER



1 DG-SD4 NOT TO SCALE -

VARIABLE VOLUME AIR HANDLER SERVING VAV TERMINAL UNIT W/ RELIEF FAN CONTROL SCHEMATIC, SEQUENCE OF OPERATIONS AND GRAPHICAL USER INTERFACE REQUIREMENTS

SEQUENCE OF OPERATION

OCCUPIED/UNOCCUPIED/SHUTDOWN MODE DETERMINATION

AIR HANDLER TO OPERATE IN OCCUPIED MODE UPON DETECTION OF SPACE OCCUPANCY BY ANY TERMINAL UNIT SERVED BY THIS AIR HANDLER. IF NO VAV TERMINAL UNITS DETECT OCCUPANCY, AIR HANDLER WILL OPERATE IN UNOCCUPIED MODE. AIR HANDLER SHUTDOWN MODE TO BE ENABLED VIA USER GRAPHICAL INTERFACE OR AT BUILDING OPERATION SERVER SCHEDULE AS AN EMERGENCY OR MAINTENANCE OVERRIDE

SUPPLY FAN OPERATION:

SUPPLY FAN OPERATION - OCCUPIED AND UNOCCUPIED MODE:
- ACTIVATION OF BUILDING OCCUPIED OR UNOCCUPIED MODE ENABLES SUPPLY FAN OPERATION [SFAN_SS]
- SUPPLY FAN SPEED [SFAN_SPD] TO MODULATE TO MAINTAIN SUPPLY AIR DISCHARGE DIFFERENTIAL PRESSURE [SFAN_DP] AT MAXIMUM SETPOINT [SFAN_DP_SP] AS DETERMINED BY TAB CONTRACTOR
- SUPPLY AIR DISCHARGE DIFFERENTIAL PRESSURE SETPOINT [SFAN_DP_SP] SHALL BE RESET TO MAINTAIN A MINIMUM OF ONE SUPPLY AIR VAV TERMINAL UNIT AT 95% OPEN WITH SUPPLY FAN MINIMUM SPEED = 25% OF MAXIMUM
- IF NO VAV TERMINAL UNITS CALL FOR AIRFLOW FOR 5 MINUTES, SUPPLY AIR FAN TO DE-ENERGIZE FOR 30 MINUTES (ADJUSTABLE)
- UPON DETECTION OF FREEZESTAT TRIP [FRZSTAT_SD], DISCHARGE HIGH OR INLET LOW STATIC [HILOSTATIC_SD], AUXILIARY DRAIN PAN MOISTURE DETECTION [PAN_SW_SD] OR FIRE ALARM ACTIVATION [FIRE_ALARM_SD] - SUPPLY FAN SHALL DEACTIVATE AND ACTIVATE ALARM SPECIFIC TO FAILURE
- ACTIVATE ALARM UPON DETECTION OF SUPPLY FAN VARIABLE FREQUENCY DRIVE GENERAL FAULT [SFAN_FAULT]
- ACTIVATE ALARM UPON DETECTION OF SUPPLY AIR DISCHARGE DIFFERENTIAL PRESSURE [SFAN_DP] BELOW SETPOINT [SFAN_DP_SP] FOR MORE THAN 15 MINUTES

SUPPLY FAN OPERATION - UNIT SHUTDOWN MODE:
- SUPPLY FAN TO DE-ENERGIZE UPON ACTIVATION OF UNIT SHUTDOWN MODE

CHILLED WATER CONTROL VALVE OPERATION:

- UPON ACTIVATION OF SUPPLY FAN [SFAN_SS], CHILLED WATER CONTROL VALVE [CHW_VLV_CMD] TO MODULATE TO MAINTAIN UNIT SUPPLY AIR DISCHARGE TEMP [S/A_TMP] BASED ON THE FOLLOWING RESET SCHEDULE: OSA >= 53F, S/A TEMP = 55F; OSA <= 30F, S/A TEMP = 62F
- UPON DEACTIVATION OF SUPPLY FAN [SFAN_SS], CHILLED WATER CONTROL VALVE [CHW_VLV_CMD] TO BE COMMANDED CLOSED
- UPON ACTIVATION OF FREEZESTAT TRIP [FRZSTAT_SD], CHILLED WATER CONTROL VALVE [CHW_VLV_CMD] TO MODULATE TO 100% OPEN
- ACTIVATE ALARM UPON DETECTION OF SUPPLY AIR DISCHARGE TEMPERATURE [S/A_TMP] 2 DEGREES ABOVE SETPOINT [S/A_TMP_SP] FOR MORE THAN 15 MINUTES
- CHILLED WATER CONTROL VALVE [CHW_VLV_CMD] TO CLOSE UPON ACTIVATION OF UNIT SHUTDOWN MODE

PREHEAT HOT WATER CONTROL VALVE OPERATION:

- UPON ACTIVATION OF SUPPLY FAN [SFAN_SS], PREHEAT COIL HOT WATER CONTROL VALVE [PRHT_VLV_CMD] TO MODULATE TO MAINTAIN PREHEAT COIL DISCHARGE TEMP [PRHT_TMP] AT 50F
- UPON DEACTIVATION OF SUPPLY FAN [SFAN_SS], PREHEAT COIL HOT WATER CONTROL VALVE [PRHT_VLV_CMD] TO BE COMMANDED CLOSED
- UPON ACTIVATION OF FREEZESTAT TRIP [FRZSTAT_SD], PREHEAT COIL HOT WATER CONTROL VALVE [PRHT_VLV_CMD] TO MODULATE TO 100% OPEN
- ACTIVATE ALARM UPON DETECTION OF PREHEAT COIL DISCHARGE TEMPERATURE [PRHT_TMP] 2 DEGREES BELOW SETPOINT [PRHT_TMP_SP] FOR MORE THAN 15 MINUTES
- PREHEAT CONTROL VALVE [PRHT_VLV_CMD] TO CLOSE UPON ACTIVATION OF UNIT SHUTDOWN MODE

OUTSIDE AIR AND RETURN AIR CONTROL DAMPER OPERATION:

OUTSIDE AIR AND RETURN AIR CONTROL DAMPER OPERATION - OCCUPIED MODE
- OUTSIDE AIR FLOWRATE SETPOINT [OSA_FLOW_SP] TO BE CALCULATED AS THE SUM OF ZONE/SPACE VENTILATION REQUIREMENTS [ZONE_OSA_REQD] PROVIDED BY TERMINAL UNITS SERVED BY AIR HANDLING UNIT. OUTSIDE AIR DAMPER [OSA_DMPR_CMD] TO MODULATE TO MAINTAIN OUTSIDE AIR FLOWRATE AS MEASURED BY AIRFLOW MONITORING STATION [OSA_FLOW]. IF OUTSIDE AIR DAMPER REACHES 100% OPEN, MODULATE RETURN AIR DAMPER [R/A_DMPR_CMD] CLOSED TO MAINTAIN MINIMUM OUTSIDE AIR FLOWRATE AT SETPOINT

OUTSIDE AIR AND RETURN AIR CONTROL DAMPER OPERATION - UNOCCUPIED MODE
- OUTSIDE AIR DAMPER [OSA_DMPR_CMD] AND RETURN DAMPER [R/A_DMPR_CMD] TO MODULATE TO MAINTAIN BUILDING PRESSURIZATION [BLDG-DP] AT 0.01" W.C. (ADJUSTABLE)

OUTSIDE AIR AND RETURN AIR CONTROL DAMPER OPERATION - UNIT SHUTDOWN MODE:
- OUTSIDE AIR DAMPER [OSA_DMPR_CMD] TO MODULATE FULLY CLOSED; RETURN DAMPER [R/A_DMPR_CMD] TO MODULATE FULLY OPEN

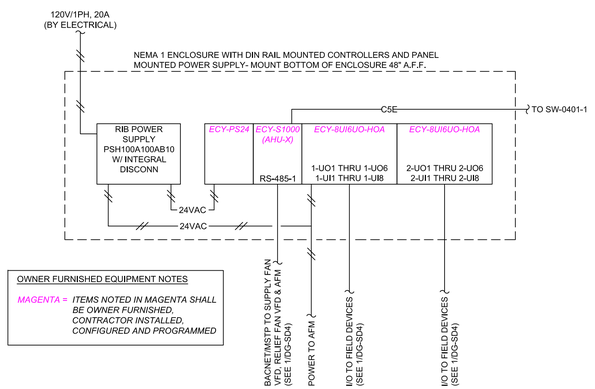
RELIEF AIR FAN OPERATION:

RELIEF FAN OPERATION - OCCUPIED MODE
- UPON ACTIVATION OF SUPPLY FAN [SFAN_SS], RELIEF FAN AUTOMATED ISOLATION DAMPER [RELFAN_DMPR] TO MODULATE FULLY OPEN AND RELIEF AIR FAN TO ACTIVATE [RELFAN_SS] AND MODULATE [RELFAN_SPD] TO MAINTAIN BUILDING PRESSURIZATION [BLDG_DP] AT 0.01" W.C. (ADJUSTABLE)
- UPON FAILURE OF RELIEF FAN, RELIEF FAN AUTOMATED ISOLATION DAMPER [RELFAN_DMPR] TO MODULATE FULLY CLOSED

RELIEF FAN OPERATION - UNOCCUPIED AND UNIT SHUTDOWN MODE - RELIEF FAN TO REMAIN DEACTIVATED

PRE-FILTER DIFFERENTIAL PRESSURE MONITORING:

- ACTIVATE ALARM UPON DETECTION OF FILTER DIFFERENTIAL PRESSURE [PREFLTR_DP] BELOW SETPOINT [PREFLTR_DP_SP] FOR MORE THAN 5 MINUTES. INITIAL SETPOINT = 1" W.C.



2 DG-SD4 NOT TO SCALE -

VARIABLE VOLUME AIR HANDLER SERVING TERMINAL UNIT CONTROL PANEL DETAIL

UA FACILITIES AUTOMATION CONTROLS DESIGN GUIDELINES

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designed:		checked:	
drawn:	SCC	date:	7/12/2022

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Sheet Title:
BACNET/IP CONTROL SYSTEM VAV AIR HANDLER STANDARD DETAILS AND SEQUENCES

Sheet No.
DG-SD4

PROGRAMMING & GRAPHICAL USER INTERFACE REQUIREMENTS

CONTROLS PROGRAMMING FOR EQUIPMENT SHOWN ON SCHEMATICS TO OCCUR AT EQUIPMENT CONTROLLER (ECY-VAV). AIR HANDLING UNIT IS TO BE PROVIDED WITH ITS OWN GRAPHICAL USER INTERFACE SCREEN/PAGE WITH GRAPHICS RESIDING ON BUILDING OPERATIONS SERVER (BOS). GRAPHICS TO DIAGRAMMATICALLY DISPLAY EQUIPMENT CONFIGURATION MATCHING INSTALLED CONDITION WITH CONTROL POINTS SHOWN IN THIS SCHEMATIC DIAGRAM DISPLAYED ON INTERFACE.

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CONTROL POINT LEGEND

[SFAN_SPD]* ——— POINT NAME
SUPPLY FAN SPEED ——— DISPLAY NAME (SHOWN ON GRAPHICS)
**ASTERISK INDICATES CONTROL POINT WITH TREND DATA COLLECTION AT 15 MINUTE INTERVALS - DATA STORAGE TO OCCUR AT BUILDING AUTOMATION SERVER*

OWNER FURNISHED EQUIPMENT NOTES

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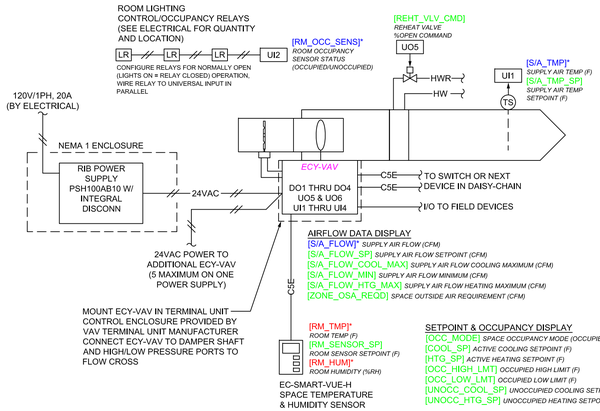


SEQUENCE OF OPERATION

TERMINAL UNIT OCCUPIED/UNOCCUPIED MODE DETERMINATION

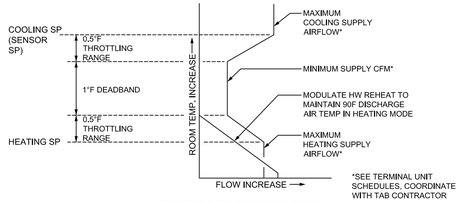
VARIABLE VOLUME TERMINAL UNIT TO OPERATE IN OCCUPIED MODE UPON DETECTION OF SPACE OCCUPANCY IN ANY SPACE SERVED BY THE TERMINAL UNIT AS DETERMINED BY LIGHTING CONTROL OCCUPANCY SENSORS. IF SPACE IS NOT OCCUPIED, TERMINAL UNIT TO OPERATE IN STANDBY MODE DURING STANDBY MODE SCHEDULED HOURS AS DETERMINED BY THE BUILDING OPERATIONS SERVER. TERMINAL UNIT TO DEFAULT TO UNOCCUPIED MODE UNDER ALL OTHER CONDITIONS

TERMINAL UNIT OPERATION:

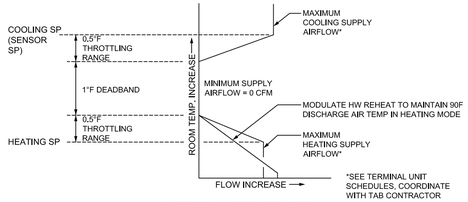
SEE OCCUPIED, STANDBY AND UNOCCUPIED MODE CONTROL TEMPERATURE/FLOW DIAGRAMS, THIS SHEET. TERMINAL UNIT TO TRANSMIT SPACE VENTILATION RATE [OSA_RATE_REQD] TO AIR HANDLING UNIT WHEN IN OCCUPIED MODE - SEE OUTSIDE AIR CALCULATIONS FOR SPACE VENTILATION RATE

ALARM OPERATION:

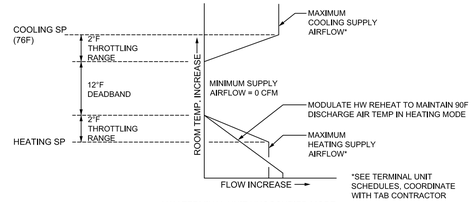
ACTIVATE ALARM UPON DETECTION OF ROOM TEMPERATURE [RM_TMP] 2 DEGREES OFF OF ACTIVE SETPOINT FOR MORE THAN 15 MINUTES. ACTIVATE ALARM UPON DETECTION OF SPACE HUMIDITY ABOVE 68% RH [RM_HUM] FOR MORE THAN 15 MINUTES



VAV TERMINAL UNIT OCCUPIED MODE



VAV TERMINAL UNIT STANDBY MODE



VAV TERMINAL UNIT UNOCCUPIED MODE

VARIABLE AIR VOLUME TERMINAL UNIT CONTROL SCHEMATIC, DIAGRAMS, SEQUENCE OF OPERATIONS AND GRAPHICAL USER INTERFACE REQUIREMENTS

1
DG-SD5
NOT TO SCALE
-

PROGRAMMING & GRAPHICAL USER INTERFACE REQUIREMENTS

CONTROLS PROGRAMMING FOR EQUIPMENT SHOWN ON SCHEMATICS TO OCCUR AT EQUIPMENT CONTROLLER (ECY-VAV). AIR HANDLING UNIT IS TO BE PROVIDED WITH ITS OWN GRAPHICAL USER INTERFACE SCREEN/PAGE WITH GRAPHICS RESIDING ON BUILDING OPERATIONS SERVER (BOS). GRAPHICS TO DIAGRAMMATICALLY DISPLAY EQUIPMENT CONFIGURATION MATCHING INSTALLED CONDITION WITH CONTROL POINTS SHOWN IN THIS SCHEMATIC DIAGRAM DISPLAYED ON INTERFACE.

CONTROL POINTS TO BE DISPLAYED ON USER GRAPHICS

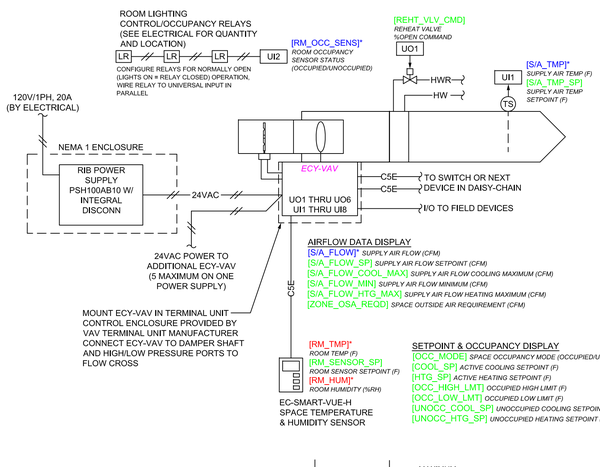
BLUE = *VALUESSTATUS POINTS DISPLAY ONLY*
GREEN = *CONTROL POINTS WITH PROGRAMMED/CALCULATED COMMAND VALUES & OVERRIDE CAPABILITY THROUGH GRAPHICS*
RED = *VALUE/STATUS POINTS WITH ALARM EXTENSION - ALARMS TO DISPLAY ON GRAPHICAL USER INTERFACE AND ON ALARM CONSOLE ON BUILDING OPERATIONS SERVER (BOS) INTERFACE*

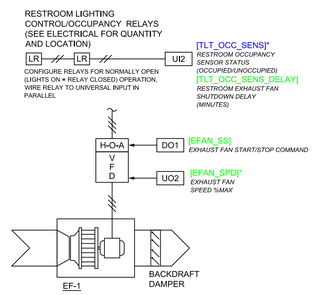
CONTROL POINT LEGEND

[SFAN_SPD]* ——— POINT NAME
SUPPLY FAN SPEED ——— DISPLAY NAME (SHOWN ON GRAPHICS)
**ASTERISK INDICATES CONTROL POINT WITH TREND DATA COLLECTION AT 15 MINUTE INTERVALS - DATA STORAGE TO OCCUR AT BUILDING AUTOMATION SERVER*

OWNER FURNISHED EQUIPMENT NOTES

MAGENTA = ITEMS NOTED IN MAGENTA SHALL BE OWNER FURNISHED, CONTRACTOR INSTALLED, CONFIGURED AND PROGRAMMED





SEQUENCE OF OPERATION

TERMINAL UNIT OCCUPIED/UNOCCUPIED MODE DETERMINATION

VARIABLE VOLUME TERMINAL UNIT TO OPERATE IN OCCUPIED MODE UPON DETECTION OF SPACE OCCUPANCY IN ANY SPACE SERVED BY THE TERMINAL UNIT AS DETERMINED BY LIGHTING CONTROL OCCUPANCY SENSORS. IF SPACE IS NOT OCCUPIED, TERMINAL UNIT TO OPERATE IN STANDBY MODE DURING STANDBY MODE SCHEDULED HOURS AS DETERMINED BY THE BUILDING OPERATIONS SERVER. TERMINAL UNIT TO DEFAULT TO UNOCCUPIED MODE UNDER ALL OTHER CONDITIONS

TERMINAL UNIT OPERATION:

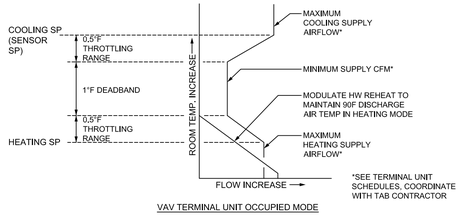
SEE OCCUPIED, STANDBY AND UNOCCUPIED MODE CONTROL TEMPERATURE/FLOW DIAGRAMS, THIS SHEET. TERMINAL UNIT TO TRANSMIT SPACE VENTILATION RATE [OSA_RATE_REQD] TO AIR HANDLING UNIT WHEN IN OCCUPIED MODE - SEE OUTSIDE AIR CALCULATIONS FOR SPACE VENTILATION RATE

ALARM OPERATION:

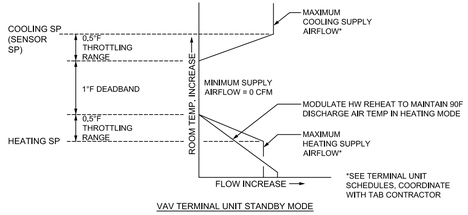
ACTIVATE ALARM UPON DETECTION OF ROOM TEMPERATURE [RM_TMP] 2 DEGREES OFF OF ACTIVE SETPOINT FOR MORE THAN 15 MINUTES. ACTIVATE ALARM UPON DETECTION OF SPACE HUMIDITY ABOVE 68% RH [RM_HUM] FOR MORE THAN 15 MINUTES

EXHAUST FAN OPERATION:

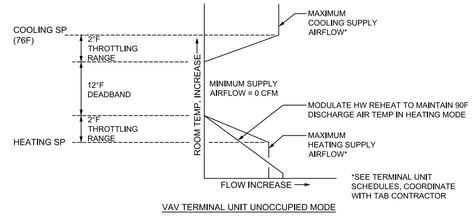
EXHAUST FAN TO OPERATE AT 100% OF MAXIMUM DESIGN SPEED UPON DETECTION OF OCCUPANCY IN RESTROOMS AS DETERMINED BY LIGHTING CONTROL OCCUPANCY SENSORS. EXHAUST FAN TO RUN FOR 30 MINUTES AFTER RESTROOM BECOMES UNOCCUPIED, COORDINATE MAXIMUM FAN SPEED SETTING WITH TAB CONTRACTOR.



VAV TERMINAL UNIT OCCUPIED MODE



VAV TERMINAL UNIT STANDBY MODE



VAV TERMINAL UNIT UNOCCUPIED MODE

VARIABLE AIR VOLUME TERMINAL UNIT WITH EXHAUST FAN CONTROL SCHEMATIC, DIAGRAMS, SEQUENCE OF OPERATIONS AND GRAPHICAL USER INTERFACE REQUIREMENTS

2
DG-SD5
NOT TO SCALE
-

UA FACILITIES AUTOMATION CONTROLS DESIGN GUIDELINES

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drawn: SCC		date: 7/12/2022	
rev	description	date	checked
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1.3	GEN. REV	10.04.22	

Sheet Title:
BACNET/IP CONTROL SYSTEM VAV TERMINAL UNIT STANDARD DETAILS AND SEQUENCES

Sheet No.
DG-SD5

PROGRAMMING & GRAPHICAL USER INTERFACE REQUIREMENTS

CONTROLS PROGRAMMING FOR EQUIPMENT SHOWN ON SCHEMATICS TO OCCUR AT EQUIPMENT CONTROLLER (ECY-S1000). AIR HANDLING UNIT IS TO BE PROVIDED WITH ITS OWN GRAPHICAL USER INTERFACE SCREEN/PAGE WITH GRAPHICS RESIDING ON BUILDING OPERATIONS SERVER (BOS). GRAPHICS TO DIAGRAMMATICALLY DISPLAY EQUIPMENT CONFIGURATION MATCHING INSTALLED CONDITION WITH CONTROL POINTS SHOWN IN THIS SCHEMATIC DIAGRAM DISPLAYED ON INTERFACE.

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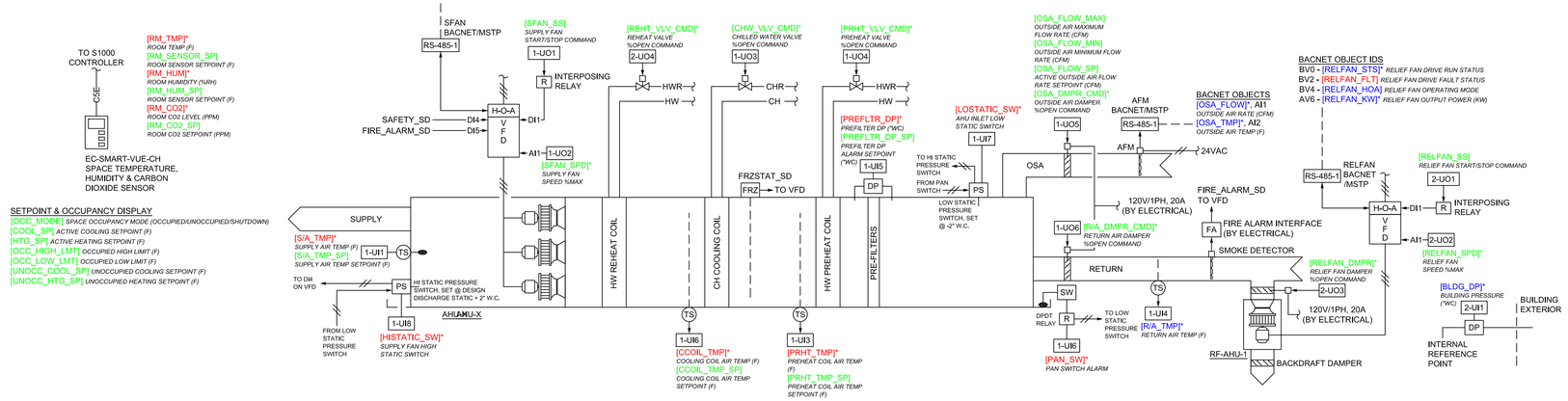
CONTROL POINT LEGEND

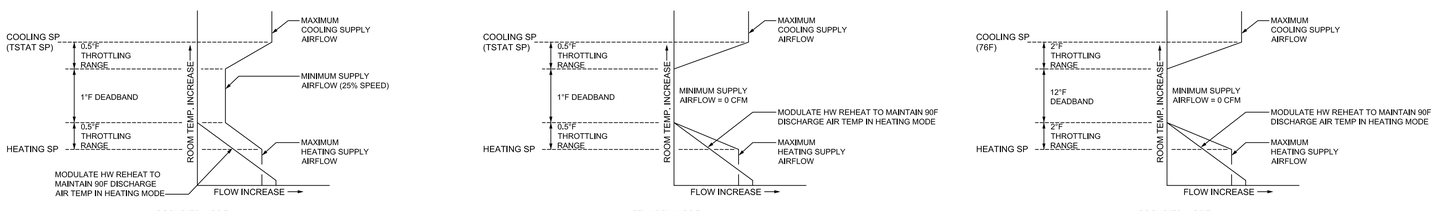
[SFAN_SPD]* ——— POINT NAME
SUPPLY FAN SPEED ——— DISPLAY NAME (SHOWN ON GRAPHICS)
**ASTERISK INDICATES CONTROL POINT WITH TREND DATA COLLECTION AT 15 MINUTE INTERVALS - DATA STORAGE TO OCCUR AT BUILDING AUTOMATION SERVER*

BACNET OBJECT IDS
BV0 - [SFAN_STS]* *SUPPLY FAN DRIVE RUN STATUS*
BV2 - [SFAN_FLT] *SUPPLY FAN DRIVE FAULT STATUS*
BV4 - [SFAN_HOA] *SUPPLY FAN OPERATING MODE*
BI0 - [SAFETY_SD] *FAN SAFETY SHUTDOWN*
BI10 - [FIRE_ALARM_SD] *FIRE ALARM SHUTDOWN*
AV6 - [SFAN_KW]* *SUPPLY FAN OUTPUT POWER (KW)*

ROOM LIGHTING CONTROL/OCCUPANCY RELAYS (SEE ELECTRICAL FOR QUANTITY AND LOCATION)
LR LR LR UI2
CONFIGURE RELAYS FOR NORMALLY OPEN (LIGHTS ON • RELAY CLOSED) OPERATION, WIRE RELAY TO UNIVERSAL INPUT IN PARALLEL
[RM_OCC_SENS]* *ROOM OCCUPANCY SENSOR STATUS (OCCUPIED/UNOCCUPIED)*



1 DG-SD6 SINGLE ZONE VARIABLE VOLUME AIR HANDLER W/ RELIEF FAN CONTROL SCHEMATIC, SEQUENCE OF OPERATIONS AND GRAPHICAL USER INTERFACE REQUIREMENTS
NOT TO SCALE



2 DG-SD6 SINGLE ZONE VARIABLE VOLUME AIR HANDLER AIRFLOW/SETPOINT DIAGRAMS
NOT TO SCALE

SEQUENCE OF OPERATION

OCCUPIED/STANDBY/UNOCCUPIED/SHUTDOWN MODE DETERMINATION

SINGLE ZONE VARIABLE VOLUME AIR HANDLER TO OPERATE IN OCCUPIED MODE UPON DETECTION OF SPACE OCCUPANCY AS DETERMINED BY LIGHTING CONTROL OCCUPANCY SENSORS. IF SPACE IS NOT OCCUPIED, AIR HANDLER TO OPERATE IN STANDBY MODE DURING STANDBY MODE SCHEDULED HOURS AS DETERMINED BY THE BUILDING OPERATIONS SERVER. UNIT TO DEFAULT TO UNOCCUPIED MODE UNLESS FULLY DEACTIVATED BY BUILDING SHUTDOWN MODE AT THE BUILDING OPERATIONS SERVER

COOLING MODE OPERATION:

WHEN SPACE IS IN COOLING MODE AS DEFINED BY AIR HANDLER SPACE TEMPERATURE SENSOR [RM_TMP], AHU CHILLED WATER CONTROL VALVE [CHW_VLV_CMD] TO MODULATE TO MAINTAIN 53F COOLING COIL DISCHARGE AIR TEMPERATURE [CCOIL_TMP] AND AHU SUPPLY FAN TO MODULATE SPEED FROM 25% TO 100% MAXIMUM SPEED [SFAN_SPD] TO MAINTAIN SPACE TEMPERATURE SETPOINT. 100% MAXIMUM SPEED TO BE DETERMINED BY TAB CONTRACTOR, SEE AIRFLOW/SETPOINT DIAGRAM. ACTIVATE ALARM UPON DETECTION OF COOLING COIL DISCHARGE TEMPERATURE [CCOIL_TMP] 2 DEGREES ABOVE SETPOINT [CCOIL_TMP_SP] FOR MORE THAN 15 MINUTES

HEATING MODE OPERATION:

WHEN SPACE IS IN HEATING MODE AS DEFINED BY AIR HANDLER SPACE TEMPERATURE SENSOR [RM_TMP], AHU REHEAT VALVE [REHT_VLV_CMD] TO MODULATE TO PROVIDE 90F DISCHARGE AIR TEMPERATURE [S/A_TEMP] AND AHU SUPPLY FAN TO MODULATE FROM 25% TO 100% MAXIMUM SPEED [SFAN_SPD] TO MAINTAIN SPACE TEMPERATURE SETPOINT, SEE AIRFLOW/SETPOINT DIAGRAM. ACTIVATE ALARM UPON DETECTION OF DISCHARGE TEMPERATURE [S/A_TMP] 2 DEGREES BELOW SETPOINT [S/A_TMP_SP] FOR MORE THAN 15 MINUTES

DEHUMIDIFICATION MODE OPERATION:

WHEN SPACE IS IN NEITHER HEATING NOR COOLING MODE AND SPACE HUMIDITY [RM_HUM] EXCEEDS SETPOINT OF 65% RH [RM_HUM_SP], RUN FAN AT MINIMUM 25% SPEED, MODULATE CHILLED WATER CONTROL VALVE TO MAINTAIN 53F CHILLED WATER COIL DISCHARGE TEMPERATURE AND MODULATE HOT WATER REHEAT TO MAINTAIN DISCHARGE AIR TEMP AT SPACE TEMPERATURE SETPOINT

GENERAL SUPPLY FAN OPERATION:

- WHEN SPACE IS IN NEITHER HEATING, COOLING, NOR DEHUMIDIFICATION MODE AND SPACE IS OCCUPIED, SUPPLY FAN SHALL RUN AT 30% SPEED.
- WHEN SPACE IS IN NEITHER HEATING, COOLING, NOR DEHUMIDIFICATION MODE AND SPACE IS UNOCCUPIED OR UNIT IS IN STANDBY, SUPPLY FAN SHALL DE-ENERGIZE.
- SUPPLY FAN TO DE-ENERGIZE UPON ACTIVATION OF UNIT SHUTDOWN MODE
- UPON DETECTION OF FREEZESTAT TRIP [FRZSTAT_SD], INLET LOW STATIC [LOSTATIC_SD], AUXILIARY DRAIN PAN MOISTURE DETECTION [PAN_SW_SD] OR FIRE ALARM ACTIVATION [FIRE_ALARM_SD] - SUPPLY FAN SHALL DEACTIVATE AND ACTIVATE ALARM SPECIFIC TO FAILURE

PREHEAT HOT WATER CONTROL VALVE OPERATION:

- UPON ACTIVATION OF SUPPLY FAN [SFAN_SS], PREHEAT COIL HOT WATER CONTROL VALVE [PRHT_VLV_CMD] TO MODULATE TO MAINTAIN PREHEAT COIL DISCHARGE TEMP [PRHT_TMP] AT 50F
- UPON DEACTIVATION OF SUPPLY FAN [SFAN_SS], PREHEAT COIL HOT WATER CONTROL VALVE [PRHT_VLV_CMD] TO BE COMMANDED CLOSED
- UPON ACTIVATION OF FREEZESTAT TRIP [FRZSTAT_SD], PREHEAT COIL HOT WATER CONTROL VALVE [PRHT_VLV_CMD] TO MODULATE TO 100% OPEN
- ACTIVATE ALARM UPON DETECTION OF PREHEAT COIL DISCHARGE TEMPERATURE [PRHT_TMP] BELOW SETPOINT [PRHT_TMP_SP] FOR MORE THAN 5 MINUTES

OUTSIDE AIR AND RETURN AIR CONTROL DAMPER OPERATION:

OUTSIDE AIR AND RETURN AIR CONTROL DAMPER OPERATION - OCCUPIED MODE
- OUTSIDE AIR DAMPER [OSA_DMPR_CMD] AND RETURN DAMPER [R/A_DMPR_CMD] TO MODULATE TO MAINTAIN MINIMUM SCHEDULED OUTSIDE AIR FLOWRATE [OSA_FLOW_MIN] AS MEASURED BY AIRFLOW MONITORING STATION [OSA_FLOW]
- OUTSIDE AIR DAMPER [OSA_DMPR_CMD] AND RETURN DAMPER [R/A_DMPR_CMD] TO MODULATE ABOVE MINIMUM OUTSIDE AIRFLOW RATE UP TO SCHEDULED MAXIMUM [OSA_FLOW_MAX] TO MAINTAIN SPACE CARBON DIOXIDE LEVEL SETPOINT [RM_CO2_SP] AS DETECTED BY ROOM CO2 SENSOR [RM_CO2]. INITIAL SETPOINT = 900 PPM CO2

OUTSIDE AIR AND RETURN AIR CONTROL DAMPER OPERATION - UNOCCUPIED MODE
- OUTSIDE AIR DAMPER [OSA_DMPR_CMD] AND RETURN DAMPER [R/A_DMPR_CMD] TO MODULATE TO MAINTAIN BUILDING PRESSURIZATION [BLDG-DP] AT 0.01" W.C. (ADJUSTABLE)

OUTSIDE AIR AND RETURN AIR CONTROL DAMPER OPERATION - BUILDING SHUTDOWN MODE:
- OUTSIDE AIR DAMPER [OSA_DMPR_CMD] TO MODULATE FULLY CLOSED; RETURN DAMPER [R/A_DMPR_CMD] TO MODULATE FULLY OPEN

RELIEF AIR FAN OPERATION:

RELIEF FAN OPERATION - OCCUPIED MODE
- UPON ACTIVATION OF SUPPLY FAN [SFAN_SS], RELIEF FAN AUTOMATED ISOLATION DAMPER [RELFAN_DMPR] TO MODULATE FULLY OPEN AND RELIEF AIR FAN TO ACTIVATE [RELFAN_SS] AND MODULATE [RELFAN_SPD] TO MAINTAIN BUILDING PRESSURIZATION [BLDG_DP] AT 0.01" W.C. (ADJUSTABLE)

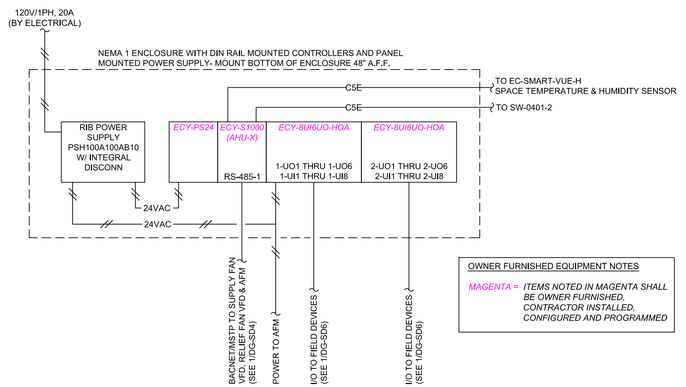
RELIEF FAN OPERATION - UNOCCUPIED AND SHUTDOWN MODE - RELIEF FAN TO REMAIN DEACTIVATED

PRE-FILTER DIFFERENTIAL PRESSURE MONITORING:

ACTIVATE ALARM UPON DETECTION OF FILTER DIFFERENTIAL PRESSURE [PREFLTR_DP] BELOW SETPOINT [PREFLTR_DP_SP] FOR MORE THAN 5 MINUTES. INITIAL SETPOINT = 1" W.C.

SPACE TEMPERATURE AND HUMIDITY ALARM OPERATION:

- ACTIVATE ALARM UPON DETECTION OF ROOM TEMPERATURE [RM_TMP] 2 DEGREES OFF OF ACTIVE SETPOINT FOR MORE THAN 15 MINUTES.
- ACTIVATE ALARM UPON DETECTION OF SPACE HUMIDITY ABOVE 68% RH [RM_HUM] FOR MORE THAN 15 MINUTES



3 DG-SD6 SINGLE ZONE VARIABLE VOLUME AIR HANDLER CONTROL PANEL DETAIL
NOT TO SCALE

UA FACILITIES AUTOMATION CONTROLS DESIGN GUIDELINES

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DEPARTMENT OF FACILITIES AND GROUNDS
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designed:		checked:	
drawn:	SCC	date:	7/12/2022

rev	description	date	checked
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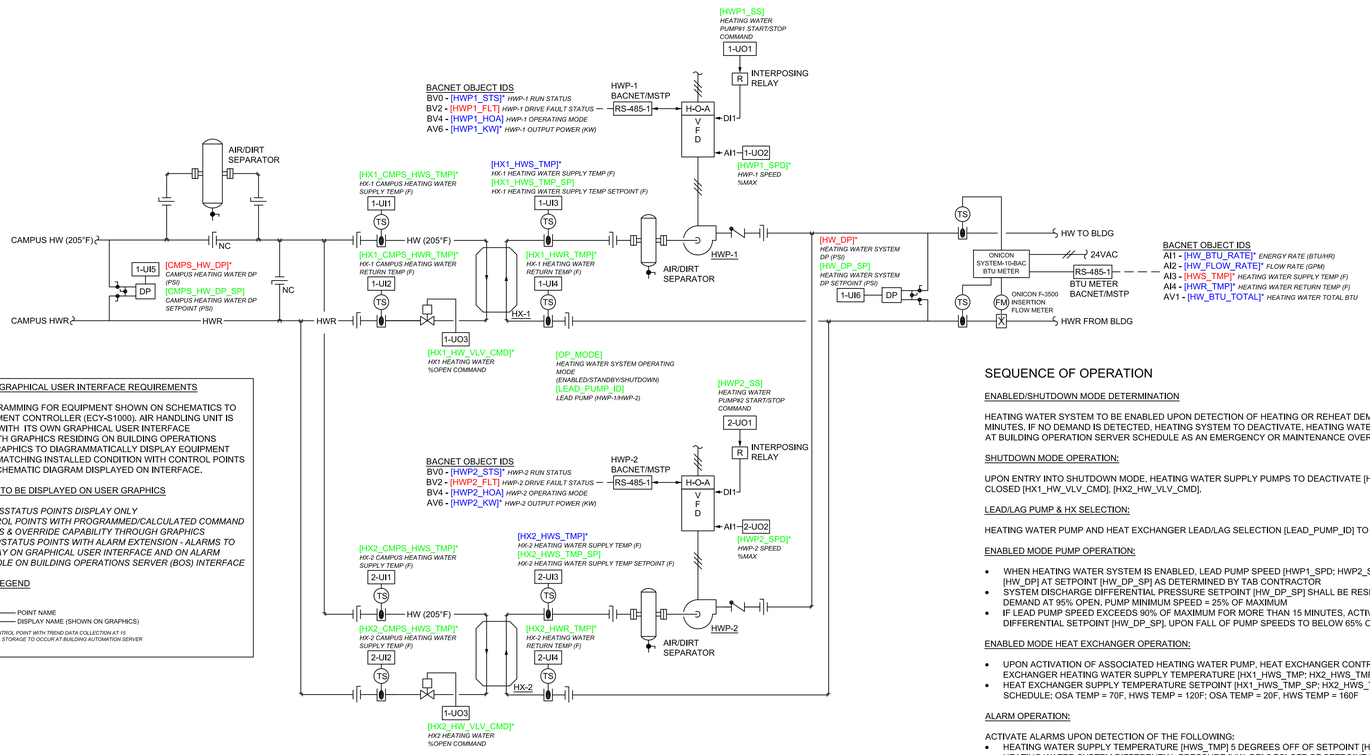
1.3	GEN. REV	10.04.22	

Sheet Title:
BACNET/IP CONTROL SYSTEM SINGLE ZONE VAV AIR HANDLER STANDARD DETAILS AND SEQUENCES

Sheet No.
DG-SD6



PROGRAMMING & GRAPHICAL USER INTERFACE REQUIREMENTS

CONTROLS PROGRAMMING FOR EQUIPMENT SHOWN ON SCHEMATICS TO OCCUR AT EQUIPMENT CONTROLLER (ECY-S1000). AIR HANDLING UNIT IS TO BE PROVIDED WITH ITS OWN GRAPHICAL USER INTERFACE SCREEN/PAGE WITH GRAPHICS RESIDING ON BUILDING OPERATIONS SERVER (BOS). GRAPHICS TO DIAGRAMMATICALLY DISPLAY EQUIPMENT CONFIGURATION MATCHING INSTALLED CONDITION WITH CONTROL POINTS SHOWN IN THIS SCHEMATIC DIAGRAM DISPLAYED ON INTERFACE.

CONTROL POINTS TO BE DISPLAYED ON USER GRAPHICS

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CONTROL POINT LEGEND

[SFAN_SPD]* ——— POINT NAME
SUPPLY FAN SPEED ——— DISPLAY NAME (SHOWN ON GRAPHICS)
**ASTERISK INDICATES CONTROL POINT WITH TREND DATA COLLECTION AT 15 MINUTE INTERVALS - DATA STORAGE TO OCCUR AT BUILDING AUTOMATION SERVER*

1 DG-SD7 CAMPUS HEATING WATER INTERFACE - CONTROL SCHEMATIC, SEQUENCE OF OPERATIONS AND GRAPHICAL USER INTERFACE REQUIREMENTS

NOT TO SCALE

SEQUENCE OF OPERATION

ENABLED/SHUTDOWN MODE DETERMINATION

HEATING WATER SYSTEM TO BE ENABLED UPON DETECTION OF HEATING OR REHEAT DEMAND AT ANY EQUIPMENT SERVED BY THE SYSTEM. MINIMUM SYSTEM RUN TIME = 15 MINUTES. IF NO DEMAND IS DETECTED, HEATING SYSTEM TO DEACTIVATE, HEATING WATER SYSTEM SHUTDOWN MODE TO BE ACTIVATED VIA USER GRAPHICAL INTERFACE OR AT BUILDING OPERATION SERVER SCHEDULE AS AN EMERGENCY OR MAINTENANCE OVERRIDE

SHUTDOWN MODE OPERATION:

UPON ENTRY INTO SHUTDOWN MODE, HEATING WATER SUPPLY PUMPS TO DEACTIVATE [HWP1_SS] & [HWP2_SS], AND HEAT EXCHANGER CONTROL VALVES TO MODULATE CLOSED [HX1_HW_VLV_CMD], [HX2_HW_VLV_CMD].

LEAD/LAG PUMP & HX SELECTION:

HEATING WATER PUMP AND HEAT EXCHANGER LEAD/LAG SELECTION [LEAD_PUMP_ID] TO BE MANUAL THROUGH GRAPHICAL USER INTERFACE

ENABLED MODE PUMP OPERATION:

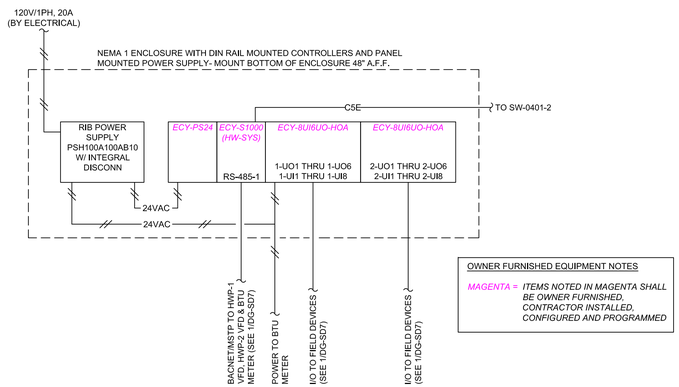
- WHEN HEATING WATER SYSTEM IS ENABLED, LEAD PUMP SPEED [HWP1_SPD; HWP2_SPD] TO MODULATE TO MAINTAIN SYSTEM DISCHARGE DIFFERENTIAL PRESSURE [HW_DP] AT SETPOINT [HW_DP_SP] AS DETERMINED BY TAB CONTRACTOR
- SYSTEM DISCHARGE DIFFERENTIAL PRESSURE SETPOINT [HW_DP_SP] SHALL BE RESET TO MAINTAIN THE HEATING SYSTEM CONTROL VALVE WITH HIGHEST PERCENTAGE DEMAND AT 95% OPEN. PUMP MINIMUM SPEED = 25% OF MAXIMUM
- IF LEAD PUMP SPEED EXCEEDS 90% OF MAXIMUM FOR MORE THAN 15 MINUTES, ACTIVATE LAG PUMP AND MODULATE PUMP SPEEDS IN UNISON TO MAINTAIN DISCHARGE DIFFERENTIAL SETPOINT [HW_DP_SP]. UPON FALL OF PUMP SPEEDS TO BELOW 65% OF MAXIMUM FOR MORE THAN 15 MINUTES, DE-ACTIVATE LAG PUMP

ENABLED MODE HEAT EXCHANGER OPERATION:

- UPON ACTIVATION OF ASSOCIATED HEATING WATER PUMP, HEAT EXCHANGER CONTROL VALVE [HX1_HW_VLV_CMD; HX2_HW_VLV_CMD], TO MODULATE TO MAINTAIN HEAT EXCHANGER HEATING WATER SUPPLY TEMPERATURE [HX1_HWS_TMP; HX2_HWS_TMP] AT SETPOINT [HX1_HWS_TMP_SP; HX2_HWS_TMP_SP]
- HEAT EXCHANGER SUPPLY TEMPERATURE SETPOINT [HX1_HWS_TMP_SP; HX2_HWS_TMP_SP] TO RESET BASED ON THE FOLLOWING OUTDOOR AIR TEMPERATURE SCHEDULE: OSA TEMP = 70F, HWS TEMP = 120F; OSA TEMP = 20F, HWS TEMP = 160F

ALARM OPERATION:

ACTIVATE ALARMS UPON DETECTION OF THE FOLLOWING:
- HEATING WATER SUPPLY TEMPERATURE [HWS_TMP] 5 DEGREES OFF OF SETPOINT [HWS_TMP_SP] FOR MORE THAN 15 MINUTES
- HEATING WATER SYSTEM DIFFERENTIAL PRESSURE [HW_DP] 5 PSI OFF OF SETPOINT [HW_DP_SP] FOR MORE THAN 15 MINUTES
- HWP-1 DRIVE FAULT [HWP1_FLT]
- HWP-2 DRIVE FAULT [HWP2_FLT]
- CAMPUS HEATING WATER DIFFERENTIAL PRESSURE [CMPS_HW_DP] 5 PSI BELOW SETPOINT [CMPS_HW_DP_SP] FOR MORE THAN 15 MINUTES



OWNER FURNISHED EQUIPMENT NOTES

MAGENTA = *ITEMS NOTED IN MAGENTA SHALL BE OWNER FURNISHED, CONTRACTOR INSTALLED, CONFIGURED AND PROGRAMMED*

2 DG-SD7 CAMPUS HEATING WATER INTERFACE CONTROL PANEL DETAIL

NOT TO SCALE

UA FACILITIES AUTOMATION CONTROLS DESIGN GUIDELINES

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drawn:	SCC	date:	7/12/2022

rev	description	date	checked
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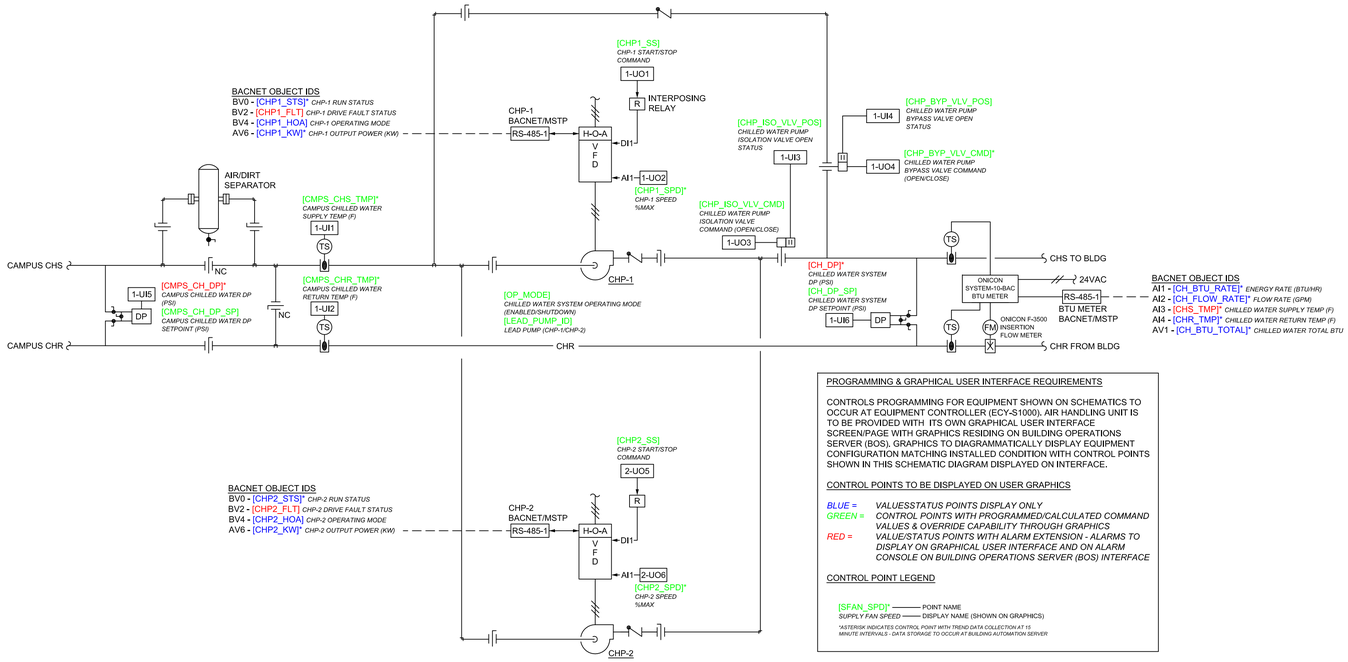
Sheet Title:

BACNET/IP CONTROL SYSTEM CAMPUS HW INTERFACE STANDARD DETAILS AND SEQUENCES

Sheet No.

DG-SD7



1 DG-SD8 CAMPUS CHILLED WATER INTERFACE - CONTROL SCHEMATIC, SEQUENCE OF OPERATIONS AND GRAPHICAL USER INTERFACE REQUIREMENTS

NOT TO SCALE

SEQUENCE OF OPERATION

ENABLED/SHUTDOWN MODE DETERMINATION

CHILLED WATER SYSTEM TO BE ENABLED UPON DETECTION OF CHILLED WATER DEMAND AT ANY EQUIPMENT SERVED BY THE SYSTEM. MINIMUM SYSTEM RUN TIME = 15 MINUTES. IF NO DEMAND IS DETECTED, CHILLED WATER SYSTEM TO DEACTIVATE. CHILLED WATER SYSTEM SHUTDOWN MODE TO BE ACTIVATED VIA USER GRAPHICAL INTERFACE OR AT BUILDING OPERATION SERVER SCHEDULE AS AN EMERGENCY OR MAINTENANCE OVERRIDE

SHUTDOWN MODE OPERATION:

UPON ENTRY INTO SHUTDOWN MODE, CHILLED WATER SUPPLY PUMPS TO DEACTIVATE [CHP1_SS] & [CHP2_SS]. CHILLED WATER PUMP ISOLATION VALVE [CHP_ISO_VLV_CMD] TO MODULATE CLOSED AND CHILLED WATER PUMP BYPASS VALVE [CHP_BYP_VLV_CMD] TO MODULATE OPEN

LEAD/LAG PUMP SELECTION:

CHILLED WATER PUMP LEAD/LAG SELECTION [LEAD_PUMP_ID] TO BE MANUAL THROUGH GRAPHICAL USER INTERFACE

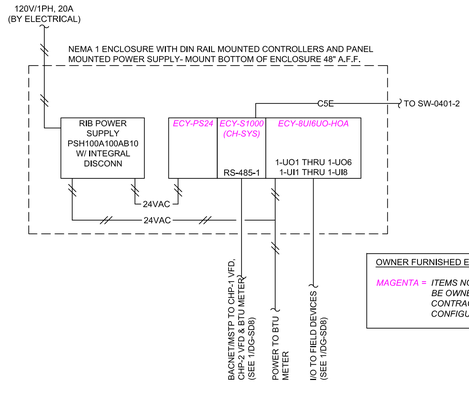
ENABLED MODE OPERATION:

- WHEN CHILLED WATER SYSTEM IS ENABLED, CHILLED WATER PUMP ISOLATION VALVE TO MODULATE CLOSED [CHP_ISO_VLV_CMD] AND CHILLED WATER PUMP BYPASS VALVE TO MODULATE [CHP_BYP_VLV_CMD] TO MAINTAIN SYSTEM DISCHARGE DIFFERENTIAL PRESSURE [CH_DP] AT SETPOINT [CH_DP_SP] AS DETERMINED BY TAB CONTRACTOR
- SYSTEM DISCHARGE DIFFERENTIAL PRESSURE SETPOINT [CH_DP_SP] SHALL BE RESET TO MAINTAIN THE CHILLED WATER SYSTEM CONTROL VALVE WITH HIGHEST PERCENTAGE DEMAND AT 95% OPEN. PUMP MINIMUM SPEED = 25% OF MAXIMUM
- IF CHILLED WATER PUMP BYPASS VALVE [CHP_BYP_VLV_CMD] EXCEEDS 90% OPEN FOR MORE THAN 15 MINUTES, MODULATE CHILLED WATER PUMP BYPASS VALVE CLOSED AND CHILLED WATER PUMP ISOLATION VALVE [CHP_ISO_VLV_CMD] OPEN. UPON DETECTION OF ISOLATION VALVE OPEN STATUS, ACTIVATE AND OPERATE LEAD PUMP TO MAINTAIN SYSTEM DISCHARGE DIFFERENTIAL SETPOINT [CH_DP_SP], MINIMUM PUMP SPEED = 25% OF MAXIMUM
- IF LEAD PUMP SPEED FALLS TO MINIMUM SPEED FOR MORE THAN 15 MINUTES, DEACTIVATE LEAD PUMP CHILLED WATER PUMP, MODULATE CHILLED WATER PUMP ISOLATION VALVE CLOSED [CHP_ISO_VLV_CMD] AND RETURN TO CHILLED WATER PUMP BYPASS VALVE CONTROL
- IF LEAD PUMP SPEED EXCEEDS 90% OF MAXIMUM FOR MORE THAN 15 MINUTES, ACTIVATE LAG PUMP AND MODULATE PUMP SPEEDS IN UNISON TO MAINTAIN DISCHARGE DIFFERENTIAL SETPOINT [CH_DP_SP]. UPON FALL OF PUMP SPEEDS TO BELOW 65% OF MAXIMUM FOR MORE THAN 15 MINUTES, DE-ACTIVATE LAG PUMP

ALARM OPERATION:

ACTIVATE ALARMS UPON DETECTION OF THE FOLLOWING:

- CHILLED WATER SUPPLY TEMPERATURE [CHS_TMP] 5 DEGREES OFF OF SETPOINT [CHS_TMP_SP] FOR MORE THAN 15 MINUTES
- CHILLED WATER SYSTEM DIFFERENTIAL PRESSURE [CH_DP] 5 PSI OFF OF SETPOINT [CH_DP_SP] FOR MORE THAN 15 MINUTES
- CHP-1 DRIVE FAULT [CHP1_FLT]
- CHP-2 DRIVE FAULT [CHP2_FLT]
- CAMPUS CHILLED WATER DIFFERENTIAL PRESSURE [CMPS_CH_DP] 5 PSI BELOW SETPOINT [CMPS_CH_DP_SP] FOR MORE THAN 15 MINUTES



2 DG-SD8 CAMPUS CHILLED WATER INTERFACE CONTROL PANEL DETAIL

NOT TO SCALE

UA FACILITIES AUTOMATION CONTROLS DESIGN GUIDELINES

Project Title:

THE UNIVERSITY OF ALABAMA
DEPARTMENT OF FACILITIES AND GROUNDS
1205 14th STREET
TUSCALOOSA, ALABAMA 35401
Phone: (205) 348-5950 Fax: (205) 348-1588

designed:		checked:	
drawn:	SCC	date:	7/12/2022

rev	description	date	checked
1.2	GEN. REV	09.06.22	
1.3	GEN. REV	10.04.22	

Sheet Title:

BACNET/IP CONTROL SYSTEM CAMPUS CH INTERFACE STANDARD DETAILS AND SEQUENCES

Sheet No.

DG-SD8

PROGRAMMING & GRAPHICAL USER INTERFACE REQUIREMENTS

CONTROLS PROGRAMMING FOR EQUIPMENT SHOWN ON SCHEMATICS TO OCCUR AT EQUIPMENT CONTROLLER (ECY-VAV). AIR HANDLING UNIT IS TO BE PROVIDED WITH ITS OWN GRAPHICAL USER INTERFACE SCREEN/PAGE WITH GRAPHICS RESIDING ON BUILDING OPERATIONS SERVER (BOS). GRAPHICS TO DIAGRAMMATICALLY DISPLAY EQUIPMENT CONFIGURATION MATCHING INSTALLED CONDITION WITH CONTROL POINTS SHOWN IN THIS SCHEMATIC DIAGRAM DISPLAYED ON INTERFACE.

CONTROL POINTS TO BE DISPLAYED ON USER GRAPHICS

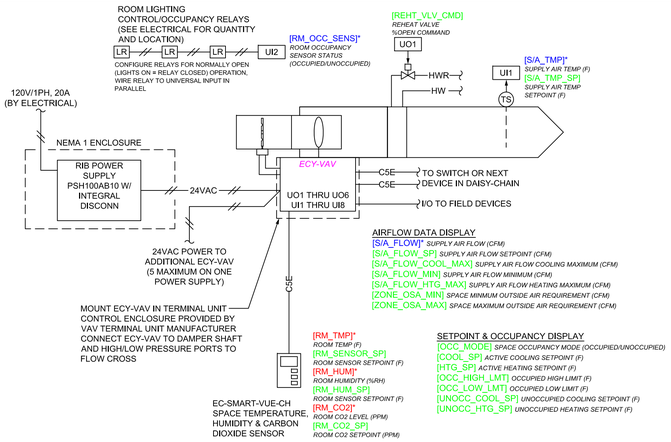
BLUE = *VALUESSTATUS POINTS DISPLAY ONLY*
GREEN = *CONTROL POINTS WITH PROGRAMMED/CALCULATED COMMAND VALUES & OVERRIDE CAPABILITY THROUGH GRAPHICS*
RED = *VALUE/STATUS POINTS WITH ALARM EXTENSION - ALARMS TO DISPLAY ON GRAPHICAL USER INTERFACE AND ON ALARM CONSOLE ON BUILDING OPERATIONS SERVER (BOS) INTERFACE*

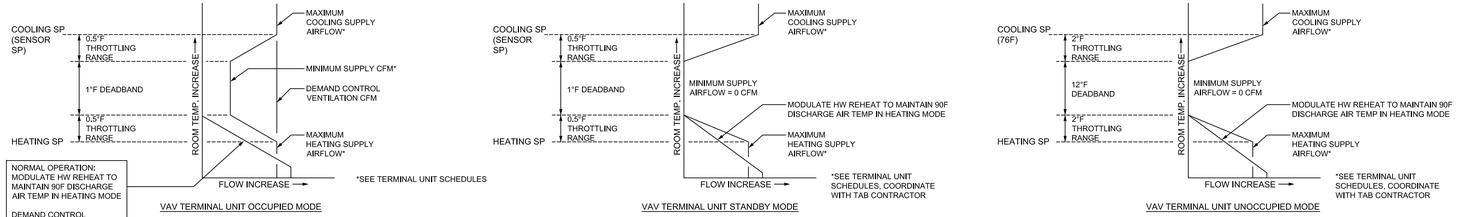
CONTROL POINT LEGEND

[SFAN_SPD]* ——— POINT NAME
SUPPLY FAN SPEED ——— DISPLAY NAME (SHOWN ON GRAPHICS)
*ASTERISK INDICATES CONTROL POINT WITH TREND DATA COLLECTION AT 15 MINUTE INTERVALS - DATA STORAGE TO OCCUR AT BUILDING AUTOMATION SERVER

OWNER FURNISHED EQUIPMENT NOTES

MAGENTA = *ITEMS NOTED IN MAGENTA SHALL BE OWNER FURNISHED, CONTRACTOR INSTALLED, CONFIGURED AND PROGRAMMED*





SEQUENCE OF OPERATION

TERMINAL UNIT OCCUPIED/UNOCCUPIED MODE DETERMINATION

VARIABLE VOLUME TERMINAL UNIT TO OPERATE IN OCCUPIED MODE UPON DETECTION OF SPACE OCCUPANCY IN ANY SPACE SERVED BY THE TERMINAL UNIT AS DETERMINED BY LIGHTING CONTROL OCCUPANCY SENSORS. IF SPACE IS NOT OCCUPIED, TERMINAL UNIT TO OPERATE IN STANDBY MODE DURING STANDBY MODE SCHEDULED HOURS AS DETERMINED BY THE BUILDING OPERATIONS SERVER. TERMINAL UNIT TO DEFAULT TO UNOCCUPIED MODE UNDER ALL OTHER CONDITIONS

TERMINAL UNIT OPERATION:

SEE OCCUPIED, STANDBY AND UNOCCUPIED MODE CONTROL TEMPERATURE/FLOW DIAGRAMS, THIS SHEET.

ROOM CARBON DIOXIDE LEVEL SETPOINT [RM_CO2_SP] = 1100 PPM. UPON DETECTION OF CO2 ABOVE SETPOINT, TERMINAL UNIT SUPPLY AIRFLOW TO MODULATE TO COOLING MAXIMUM FLOWRATE UNTIL CO2 LEVELS DROP 300 PFM BELOW SETPOINT.

TERMINAL UNIT TO TRANSMIT MINIMUM SPACE VENTILATION RATE [OSA_RATE_MIN] TO AIR HANDLING UNIT WHEN IN OCCUPIED MODE - SEE OUTSIDE AIR CALCULATION ADJUSTED AREA VENTILATION RATE FOR THIS VALUE. UPON CALL FOR ADDITIONAL VENTILATION BY CARBON DIOXIDE SENSORS, TERMINAL UNIT TO TRANSMIT TO AIR HANDLING UNIT MAXIMUM SPACE VENTILATION RATE [OSA_RATE_MAX] - SEE OUTSIDE AIR CALCULATION ADJUSTED AREA + OCCUPANT VENTILATION RATE FOR THIS VALUE

ALARM OPERATION:

ACTIVATE ALARM UPON DETECTION OF ROOM TEMPERATURE [RM_TMP] 2 DEGREES OFF OF ACTIVE SETPOINT FOR MORE THAN 15 MINUTES, ACTIVATE ALARM UPON DETECTION OF SPACE HUMIDITY ABOVE 68% RH [RM_HUM] FOR MORE THAN 15 MINUTES

VARIABLE AIR VOLUME TERMINAL UNIT, HIIGH OCCUPANCY DEMAND CONTROL VENTILATION APPLICATION CONTROL SCHEMATIC, DIAGRAMS, SEQUENCE OF OPERATIONS AND GRAPHICAL USER INTERFACE REQUIREMENTS

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PROGRAMMING & GRAPHICAL USER INTERFACE REQUIREMENTS

CONTROLS PROGRAMMING FOR EQUIPMENT SHOWN ON SCHEMATICS TO OCCUR AT EQUIPMENT CONTROLLER (ECY-VAV). AIR HANDLING UNIT IS TO BE PROVIDED WITH ITS OWN GRAPHICAL USER INTERFACE SCREEN/PAGE WITH GRAPHICS RESIDING ON BUILDING OPERATIONS SERVER (BOS). GRAPHICS TO DIAGRAMMATICALLY DISPLAY EQUIPMENT CONFIGURATION MATCHING INSTALLED CONDITION WITH CONTROL POINTS SHOWN IN THIS SCHEMATIC DIAGRAM DISPLAYED ON INTERFACE.

CONTROL POINTS TO BE DISPLAYED ON USER GRAPHICS

BLUE = *VALUESSTATUS POINTS DISPLAY ONLY*
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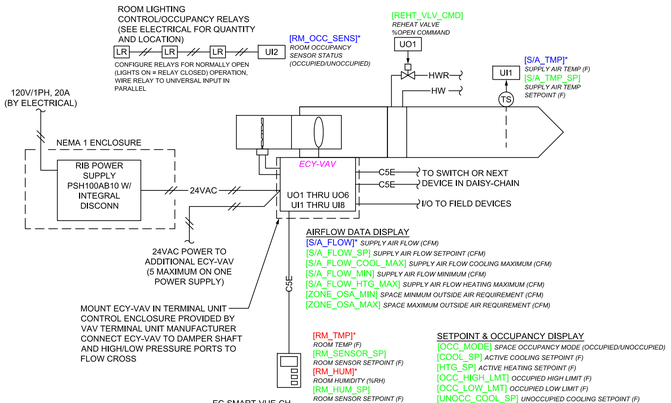
RED = *VALUE/STATUS POINTS WITH ALARM EXTENSION - ALARMS TO DISPLAY ON GRAPHICAL USER INTERFACE AND ON ALARM CONSOLE ON BUILDING OPERATIONS SERVER (BOS) INTERFACE*

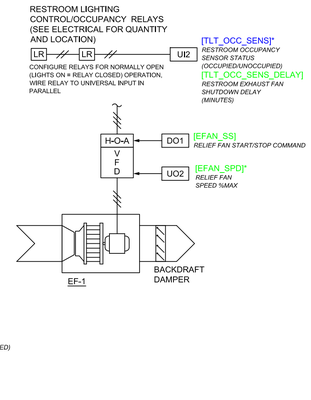
CONTROL POINT LEGEND

[SFAN_SPD]* ——— POINT NAME
SUPPLY FAN SPEED ——— DISPLAY NAME (SHOWN ON GRAPHICS)
*ASTERISK INDICATES CONTROL POINT WITH TREND DATA COLLECTION AT 15 MINUTE INTERVALS - DATA STORAGE TO OCCUR AT BUILDING AUTOMATION SERVER

OWNER FURNISHED EQUIPMENT NOTES

MAGENTA = *ITEMS NOTED IN MAGENTA SHALL BE OWNER FURNISHED, CONTRACTOR INSTALLED, CONFIGURED AND PROGRAMMED*





SEQUENCE OF OPERATION

TERMINAL UNIT OCCUPIED/UNOCCUPIED MODE DETERMINATION

VARIABLE VOLUME TERMINAL UNIT TO OPERATE IN OCCUPIED MODE UPON DETECTION OF SPACE OCCUPANCY IN ANY SPACE SERVED BY THE TERMINAL UNIT AS DETERMINED BY LIGHTING CONTROL OCCUPANCY SENSORS. IF SPACE IS NOT OCCUPIED, TERMINAL UNIT TO OPERATE IN STANDBY MODE DURING STANDBY MODE SCHEDULED HOURS AS DETERMINED BY THE BUILDING OPERATIONS SERVER. TERMINAL UNIT TO DEFAULT TO UNOCCUPIED MODE UNDER ALL OTHER CONDITIONS

TERMINAL UNIT OPERATION:

SEE OCCUPIED, STANDBY AND UNOCCUPIED MODE CONTROL TEMPERATURE/FLOW DIAGRAMS, THIS SHEET.

ROOM CARBON DIOXIDE LEVEL SETPOINT [RM_CO2_SP] = 1100 PPM. UPON DETECTION OF CO2 ABOVE SETPOINT, TERMINAL UNIT SUPPLY AIRFLOW TO MODULATE TO COOLING MAXIMUM FLOWRATE UNTIL CO2 LEVELS DROP 300 PFM BELOW SETPOINT.

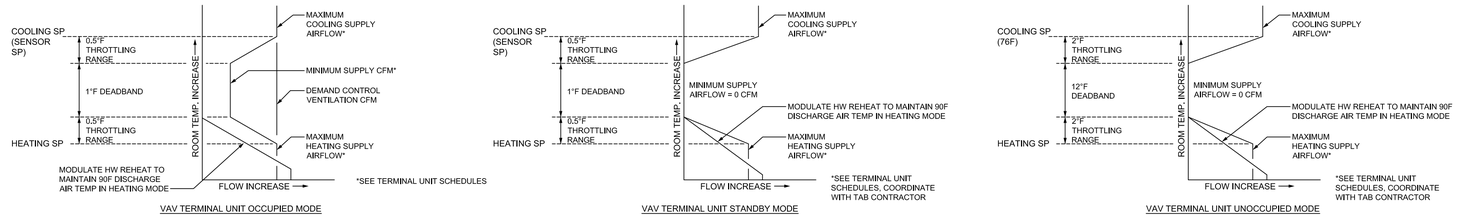
TERMINAL UNIT TO TRANSMIT MINIMUM SPACE VENTILATION RATE [OSA_RATE_MIN] TO AIR HANDLING UNIT WHEN IN OCCUPIED MODE - SEE OUTSIDE AIR CALCULATION ADJUSTED AREA VENTILATION RATE FOR THIS VALUE. UPON CALL FOR ADDITIONAL VENTILATION BY CARBON DIOXIDE SENSORS, TERMINAL UNIT TO TRANSMIT TO AIR HANDLING UNIT MAXIMUM SPACE VENTILATION RATE [OSA_RATE_MAX] - SEE OUTSIDE AIR CALCULATION ADJUSTED AREA + OCCUPANT VENTILATION RATE FOR THIS VALUE

ALARM OPERATION:

ACTIVATE ALARM UPON DETECTION OF ROOM TEMPERATURE [RM_TMP] 2 DEGREES OFF OF ACTIVE SETPOINT FOR MORE THAN 15 MINUTES. ACTIVATE ALARM UPON DETECTION OF SPACE HUMIDITY ABOVE 68% RH [RM_HUM] FOR MORE THAN 15 MINUTES

EXHAUST FAN OPERATION:

EXHAUST FAN TO OPERATE AT 100% OF MAXIMUM DESIGN SPEED UPON DETECTION OF OCCUPANCY IN RESTROOMS AS DETERMINED BY LIGHTING CONTROL OCCUPANCY SENSORS. EXHAUST FAN TO RUN FOR 30 MINUTES AFTER RESTROOM BECOMES UNOCCUPIED. COORDINATE MAXIMUM FAN SPEED SETTING WITH TAB CONTRACTOR.



VARIABLE AIR VOLUME TERMINAL UNIT, HIIGH OCCUPANCY DEMAND CONTROL VENTILATION APPLICATION WITH EXHAUST FAN CONTROL SCHEMATIC, DIAGRAMS, SEQUENCE OF OPERATIONS AND GRAPHICAL USER INTERFACE REQUIREMENTS

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DG-SD9
NOT TO SCALE

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Project Title:
UA FACILITIES AUTOMATION CONTROLS DESIGN GUIDELINES

designed:		checked:	
drawn:	SCC	date:	7/12/2022

rev	description	date	checked
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Sheet Title:
BACNET/IP CONTROL SYSTEM VAV TERMINAL UNIT WITH HIGH OCCUPANCY STANDARD DETAILS AND SEQUENCES

Sheet No.
DG-SD9

University of Alabama Design Standards

Division 25 – Integrated Automation Guideline Specifications

September 2022

THE UNIVERSITY OF ALABAMA®

Division 25 | Integrated Automation Systems

This guideline specification is written for the designer of record's (DOR) review and use. This specification is written to document UA standards of work, assist the designers in ensuring UA standards are incorporated into the contract documents, and provide a resource to facilitate the design process. It is the DOR's responsibility to review the guideline specification against the project systems design and coordinate/edit the specification to match project specific requirements.

This guideline specification is not intended to include all requirements necessary for the design of Integrated Automation Systems but to indicate University preferences where they exist. Input from the DOR is encouraged when new practices, products, or systems are available which may increase the value of the installed Integrated Automation Systems but may be in conflict with these guidelines. Any such recommendations may be presented to the Campus Development architectural and engineering staff during project design phase.

Section 25 05 01 – Integrated Automation System General Requirements

PART 1 - GENERAL

1.1 Related Sections

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Section 25 05 02, Integrated Automation System Submittals

C. Section 25 05 03, Integrated Automation System Project Record Documents

D. Section 25 05 04, Integrated Automation System Start-Up, Verification and Commissioning

E. Section 25 05 05, Integrated Automation System Training

F. Section 25 10 01, Integrated Automation System Networks

G. Section 25 10 02, Integrated Automation System Computer Systems, MMI

H. Section 25 30 01, Integrated Automation System Field Controllers

I. Section 25 35 13, Integrated Automation System Actuators and Operators

J. Section 25 35 16, Integrated Automation System Sensors and Transmitters

K. Section 25 35 19, Integrated Automation System Control Valves

L. Section 25 35 27, Integrated Automation System Variable Frequency Drives

M. Section 25 35 30, Integrated Automation System Tubing, Cabling and Raceway

1.2 Summary

A. This project requires the [expansion of an existing][installation of a new] Integrated Automation System (IAS) constructed using BACnet Field Level Devices. The IAS shall utilize single or multiple Building Operations Servers (BOS) based on point counts and available resources utilizing a web interface to all controlled devices.

B. The IAS Contractor will be required to perform the following:

1. Provide a new Integrated Automation System with BACnet fully programmable and application specific DDC controllers for the equipment identified in the IAS drawings, including:

   a. [Air Handling Units (AHUs)]

   b. [Make-Up Air Handling Units (MUAs)]

c. [Exhaust Fans (EFs)]

d. [Relief Fans (RFs)]

e. [Energy Recovery Units (ERUs)]

f. [Heating & Ventilating Units (HVs)]

g. [Computer Room Air Conditioners (CRACs)]

h. [Variable Air Volume Terminal Units (VAVs)]

i. [Fan Coil Units (FCUs)]

j. [Automatic Transfer Switch (ATS)]

k. [Lighting Controls]

l. [Irrigation Water]

2. Provide Graphical User Interface Development for all of the devices identified above and illustrated within the IAS drawings.
3. Graphical User Interface development must match existing graphics, tool sets and features.
4. Furnish and install all items listed below in Section 1.3 General IAS Installation Scope of Work.
5. Review all of the design documents and specifications and report any discrepancies to the designer of record.

1.3 General IAS Installation Scope of Work

A. Contractor shall [expand on the existing][or install a new] IAS by furnishing and installing system to provide an open protocol, enterprise based, direct digital control, Integrated Automation System.

B. The new IAS components shall utilize network controllers, BACnet protocol, BTL certified devices, enterprise connectivity, electronic sensing, microprocessor-based digital control, and electronic actuation of dampers and valves to perform control sequences and functions specified.

C. The IAS will consist of monitoring and control of systems identified within the IAS drawings, which include integration of HVAC, power monitoring, lighting control and other systems as outlined.

D. The installation of Network Controllers and DDC control system devices for the HVAC equipment as illustrated on the IAS drawings and detailed in these specifications.

E. This includes all hardware, electrical installation, configuration, programming and commissioning coordination for the DDC system.

F. IAS Contractor shall implement an open system that will allow products from various suppliers to be integrated into a unified system in order to provide flexibility for expansion, maintenance, and service of the system.

G. The Owner shall be the named license holder of all software associated with any and all incremental work on the project.

H. Provide an Integrated System supplied by a company regularly engaged in the manufacturing and distribution of building automation systems. The IAS Manufacturer shall meet the following qualifications as a minimum:

1. The manufacturer of the hardware and software components must be primarily engaged in the manufacture of building integration automation systems as specified herein, and must have been so for a minimum of three (5) years.
2. The manufacturer of the hardware and software components as well as its subsidiaries must be a member in good standing of the BACnet International.

I. The Owner shall receive ownership of all job specific configuration documentation, data files, and application-level software developed for the project.

1. This shall include all custom, job specific software code and documentation for all configuration and programming that is generated for a given project and/or configured for use with the NAC, FMCS Server(s), and any related LAN / WAN / Intranet and Internet connected routers and devices.
2. Any and all required IDs and passwords for access to any component or software program shall be provided to the Owner.

J. Intelligent Equipment Integration. Network installation, software integration, network communication, and equipment configuration for all equipment types specified to be "Intelligent" shall be provided with a factory installed or equipment manufacturer provided communication card.

K. Refer to IAS drawings and coordinate with Mechanical and Electrical contractors to verify the correct communication options have been supplied.

L. The IAS Contractor shall coordinate with other trades to ensure that all equipment to be integrated is ordered with the proper communication cards and/or equipment required for proper integration.

M. All hardware installed for the project shall be constructed in a modular fashion to permit the next generation and support components to be installed in replace of or in parallel with existing components.

N. Where the project is an expansion of an existing system the Software utilized for the project shall be backward compatible with earlier releases, whenever possible.

O. Provision of all documentation called out in these specifications including, but not limited to, submittals, O&M manuals, commissioning submittals, CAD or Visio based as-built documentation, and training manuals.

P. Hardware, Software and Labor as detailed and described on the IAS drawings and the Division 25 specifications.

Q. [Coordination and assistance provided to the commissioning authority for system commissioning.]

1. [Provide staff to operate and manipulate the system as required by the commissioning authority in addition to providing the requested documentation as defined in the commissioning specification.]

R. [Repair of all finished surfaces effected as a result of IAS related installation work. This includes but is not limited to carpet, drywall, paint ceiling tiles, furniture, and the like.]

S. DDC Controller programming and commissioning.

1. System point to point check out, verification and documentation.

T. Graphical User Interface Development.

1. The Contractor shall develop the graphics, tools, features, and network integration required and as defined in section 25 10 02.

U. The low voltage and communication raceway systems, wiring and terminations.

V. All requirements, products, and labor as identified in the Division 25 specifications and IAS Drawings.

1.4 Codes

A. Comply with Alabama State Building Code and the City of Tuscaloosa.

B. In all cases of conflict between the work of this Division, the Alabama State Building Code and the City of Tuscaloosa these details shall be brought to the attention of the Architect/Engineer at the time of bid proposal submission.

C. It is the Contractor's responsibility to identify any items of conflict or omission. These items shall be resolved prior to bid submission and included in the bid proposal price.

D. Where codes are listed herein, the applicable portions of the latest editions apply.

E. Drawings, specifications, codes and standards are minimum requirements. Where requirements differ, apply the more stringent.

F. Should any change in Drawings or Specifications be required to comply with regulations, the Contractor shall notify the Architect/Engineer prior to execution of the work and wait for direction from the Architect/Engineer.

1.5 Reference Standards

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship whose compliance with organizational standards/codes/specifications is regulated by an organization using its own listing or label as proof of compliance, furnish listing or label as required to ensure material complies with applicable referenced standard or specification.

D. All materials, installation and workmanship whose compliance with organizational standards/codes/specifications is not regulated by an organization using its own listing or label as proof of compliance, furnish certificate stating that material complies with applicable referenced standard or specification.

1.6 Fees and Permits

A. Pay applicable fees and permits.

B. Pay royalties and fees required in connection with the use of patented devices and systems.

1.7 Coordination of Work with Existing Conditions

A. Examine and compare the Integrated Automation System (IAS) Specifications and Drawings with the Specifications and Drawings of the other trades and report any discrepancies between them to the Owner.

B. Obtain the Architect/Engineer's written instructions for changes necessary in the IAS work. Install and coordinate the IAS work in cooperation with the Commissioning Authority and the other trades installing interrelated work.

C. Before installation, make proper provisions to avoid interferences in a manner approved by the Architect/Engineer.

D. All changes required in the work of the Contractor, caused by noncompliance with the specifications, shall be made at the Contractor's expense.

E. Certain products, systems and interface devices may be provided by other trades.

F. Examine the Contract Documents to ascertain the requirements to install, wire, program, commission, and/or interface to these systems.

G. Particular attention must be paid towards the interface boards submitted by the various equipment providers.

H. It is the Contractor's responsibility to verify the submitted interfaces will integrate properly into the IAS. Report any discrepancies to the Architect/Engineer.

I. Carefully check space requirements with other trades to ensure that all material can be installed in the allotted spaces, including above finished suspended ceilings and under floors.

J. Transmit to other trades information required for work to be provided under their respective sections in ample time for installation.

K. Wherever work interconnects with work of other trades, coordinate with other trades and with the Owner's representative to ensure that all trades have the information necessary so that they may properly install all the necessary connections and equipment.

L. Identify all work items (valves, dampers, coils, etc.) in an accepted manner and notify the responsible trade to install access doors and panels at these locations.

M. Provide sleeves and conduit for passage of pipes, and wiring through structural masonry, concrete walls and floors, and elsewhere for the proper protection of the IAS work.

N. Coordinate, project and schedule work with other trades and with the Commissioning Authority in accordance with the construction sequence.

O. Adjust locations of panels, equipment, devices, and the like, to accommodate work and prevent interferences. Determine the exact route and location of each pipe, conduit or tubing prior to fabrication and installation.

1.8 Definitions

1. Adjustable (Adj): A characteristic of a control logic parameter such that it can be varied by the operator without downloading the program.
2. Advanced Application Controller (AAC): A device with limited resources relative to the Building Controller (BC). It may support a level of programming and may also be intended for application specific applications.
3. Algorithm: A logical procedure for solving a recurring problem.
4. Analog: A continuously varying signal value (temperature, current, velocity, etc.).
5. Application Programming Tool: A vendor unique software tool used to create applications for programmable controllers. This software tool may also be used for system programming, controller commissioning, network management.
6. Application Protocol Data Unit (APDU): A unit of data specified in an application protocol and consisting of application protocol control information and possible application user data (ISO 9545).
7. Application Specific Controller (ASC): Control product that incorporates solid-state components based upon a microprocessor to perform multiple control loops or functions as part of a specific application.
    a. ASC shall conform to the BACnet/BTL certification and integration standards
8. BACnet or BACnet Standard: BACnet communication requirements as defined by ASHRAE/ANSI 135 and all current addenda and annexes.
9. BACnet Interoperability Building Blocks (BIBB): BIBB defines a small portion of BACnet functionality that is needed to perform a particular task.
    a. BIBBS are combined to build the BACnet functional requirements for a device in a Specification.
10. BACnet over Internet Protocol (BACnet/IP): BACnet communication requirements as defined by ASHRAE/ANSI 135 and all current addenda and annexes utilizing Internet Protocol addressing as described in IETF publication RFC 791.
11. BACnet over Master Slave Token Passing Protocol (BACnet MS/TP or MS/TP): BACnet communication requirements as defined by ASHRAE/ANSI 135 and all current addenda and annexes utilizing a master slave token passing network scheme utilizing RS-485 communications.

12. Bandwidth Utilization: The average utilization of the network capacity. Generally speaking the amount of present network traffic as it relates to the maximum amount of traffic for which a network can support.
13. Binary: A two-state system where a high signal level represents an "on" condition and an "off" condition is represented by a low signal level.
14. Binding: In the general sense, binding refers to the associations or mappings of the sources network variables or objects and their intended or required destinations.
    a. The concept of associating an output network variable from one device to the input network variable of a second (third, fourth, etc.) device.
15. Bridge: A device that routes messages or isolates message traffic to a particular segment, sub-net or domain of the same physical communication media.
16. Building Operations Server (BOS): A device that incorporates 1 or more network service host APIs to perform localized network management and network access services over a group of channel(s).
    a. Supervises groups of intelligent devices and Control Units to perform a global sequence of operation (ex: fire and life safety control).
    b. Can be configured to serve as a SCADA client on the IAS, Tier 1, and Local Area Network.
    c. Provides integration to Enterprise level systems and other protocols.
    d. The BOS serves the following key functions:
        1) Time Schedules: Time schedule algorithms shall reside in the BOS. Occupancy/energize commands shall be broadcast to the equipment level controllers in the number required by the sequence of control.
        2) Trend Data Storage: The BOS shall collect data from the equipment level controls at specified intervals and store the data for periodic uploading to the server. Polling communication techniques are acceptable for data collection by the network controller.
        3) Alarm Generation: The BOS shall receive binary alarm variables from the building level controllers and transmit this data to the alarm handling software module within the server and operator work stations. Receipt of alarm data from the building level controls shall be based on broadcasting from the building level controls and not based on polling by the Network Controller.
        4) Interlock and control: The network controller shall perform sequence of operation logic and control where appropriate.
        5) Control Systems Server:
            a) Maintains system configuration and programming database.
            b) Holds the backup files of the information downloaded into the individual controllers and as such support uploading and downloading that information directly to/from the controllers.
            c) Acts as a control information server to non-control system-based programs. All allows secure multiple-access to the control information.
17. Bus Topology: A term used to describe the sequential connection of devices on a DLN segment. The communication cable runs from device to device with no tees or stubs from the main communication cable to a device.
18. Change of Value (COV): An event that occurs when a measured or calculated analog value changes by a predefined amount.

19. Channel: A DLN network consisting of two segments connected by a physical layer repeater or router configured as a repeater.
    a. Each segment can support a theoretical limit of 64 connections.
20. Client: A device that is the requestor of services from a server.
    a. A client device makes requests of and receives responses from a server device.
21. Commissioning: A process of ensuring that systems are installed, functionally tested and capable of being operated and maintained to perform in conformity with design intent.
    a. Control System commissioning requires a point to point check out and the detail documentation of each parameter.
    b. Commissioning includes a complete functional test of the sequence of operation for each piece of equipment.
22. Continuous Monitoring: A sampling and recording of a variable based on time or change of state (e.g. trending an analog value, monitoring a binary change of state).
23. Control Wiring: Includes conduit, wire and wiring devices to install complete control systems including HVAC control, switchgear, uninterruptible power supplies, lighting, security, interlocks, thermostats, EP and IP switches and like devices.
    a. Includes all wiring from Intelligent Devices and Controllers to all sensors and points defined in the input/output summary shown on the drawings or specified herein and required to execute the sequence of operation.
24. Controller or Control Unit (CU): Intelligent stand-alone control panel.
    a. Controller is a generic reference and shall include Building Operations Servers (BOS), Equipment Controllers (EC) and Terminal Controllers (TC) as appropriate.
25. Control Systems Server (CSS): A computer that maintains the systems configuration and programming database.
    a. This may double as an operator workstation for smaller systems.
26. Deadband: A temperature or lighting range over which no heating, cooling, or lighting energy is supplied as opposed to single point changeover or overlap.
27. Device instance: A number that uniquely identifies a device on the Device Level Network (DLN).
28. Direct Digital Control (DDC): Microprocessor-based control including Analog/Digital conversion and program logic.
29. Discrete: Binary or digital state.
30. Distributed Control: A system whereby control processing is decentralized and independent of a central computer.
31. Diagnostic Program: Machine-executable instructions used to detect and isolate system and component malfunctions.
32. DLN: Device Level Network – The local control system network that incorporates servers, control devices and software applications.
33. EEPROM: Electrically Erasable Programmable Read-Only Memory – non-volatile, user modifiable, read-only memory that can be erased and reprogrammed repeatedly through the application of a higher than normal electrical voltage.
34. FAC LAN: Facility Local Area Network.
35. Functional Profile: A collection of variables required to define key parameters for a standard application.

a. For the HVAC industry, this includes applications like VAV terminal units, fan coil units, etc.

36. Gateway: A device, which contains two or more dissimilar networks/protocols, permitting information exchange between dissimilar systems.
37. Graphical User Interface (GUI): A Man Machine Interface device (PC, laptop or dumb display terminal) which incorporates web browsing for remote network client services as a thin client machine.
    a. The Graphical User Interfacing allows the operator to manage, command, monitor, configure and program the system.
    b. It shall function as the point of interface for all control and monitoring functions as well as all data logs, trends, and alarming.
38. Hand Held Device (HHD): Manufacturer's microprocessor based device for direct connection to a Controller.
39. HTTP: Hypertext Transfer Protocol: the set of rules for exchanging data files (text, graphic images, sound, video and other multimedia files) over the Internet.
40. Integrated Automation System (IAS). The complete facility control system comprised of mechanical system automation, security control, lighting control, automatic temperature control, etc., as defined in the contract documents.
    a. The IAS is comprised of a tiered network structure.
    b. The primary tier uses Ethernet, TCP/IP protocol in a 10/100/1000 Base T wiring configuration.
        1) The IAS also includes interface panels, bridges, network controllers, LAN wiring, raceways, etc.
        2) All system data shall be made available to the Owner's Wide Area Network for building management.
        3) The functionality of the system will allow building engineers the ability to view and modify the facility from any point on the Owner's WAN.
    c. The second tier uses BACnet for distributed control processing.
41. Interface Panel: A device that contains an I/O software driver to translate data from a particular format to that conforming to BACnet standards. Also see Gateway.
42. IT LAN: Reference to the facility's Information Technology network, used for normal business-related e-mail and Internet communication.
43. LAN: Local Area Network – a group of computers and/or associated devices which share a common communications line and typically share the resources of a single processor or server within a small geographic area.
44. LAN Interface Device (LANID): Device or function used to facilitate communication and sharing of data throughout the IAS.
45. MAC address: The MAC (Media Address Control) address uniquely identifies a device on its MS/TP network.
46. Master Devices: Master devices can initiate requests for data but require more processing and memory capacity than slave devices.
47. Master-Slave/Token Passing (MS/TP) network segment: An electrically separate section of a network. An MS/TP network segment contains no more than 32 full Unit Loads. Repeaters connect the segments of an MS/TP network.
48. Maximum Send Time Parameter: A parameter used to ensure the periodic update of network data. If a time period equal to the value of this parameter has expired without a broadcast of

the variable, a re-broadcast of the current value shall be executed. See also minimum send time parameter definitions.

49. Minimum Send Time Parameter: A parameter used to control unnecessary broadcasting of data onto the network. A broadcast of an updated value shall not occur unless a time period equal to the value of this parameter has expired. The expiration of the time period does not mandate a re-broadcast. See also maximum send time parameter definitions.
50. Network: A system of distributed control units and intelligent devices that are linked together on a communications bus. A network allows sharing of point information between all control units. Additionally, a network provides central monitoring and control of the entire system from any distributed control unit location.
51. Node: A device connected to a communications network.
52. Open Database Connectivity (ODBC): An open standard application-programming interface (API) for accessing a database. ODBC compliant systems make it possible to access any data from any application, regardless of which database management system (DBMS) is handling the data.
53. Operator Interface (OI): A device used by the operator to manage the EMCS including OWSs, POTs, and HHDs.
54. Operating System (OS): Software which controls the execution of computer programs and which provides scheduling, debugging, input/output controls, accounting, compilation, storage assignment, data management, and related services.
55. Operator Workstation (OWS): A Man Machine Interface device (PC, laptop or display terminal) which incorporates web browsing for remote network client services.
56. Peripheral: Input/Output equipment used to communicate to and from the computer and make hard copies of system outputs and electronic files. Peripherals include CRT, printer, hard drives, disk drives, modems, etc.
57. Point: Analog or discrete instrument with addressable database values.
58. Point-to-Point (PTP): Serial communication as defined in the BACnet standard.
59. Polling: The concept of a control device requesting a network variable from a second control device at a specified interval.
60. Polling communication is typically used to populate dynamic data on an active graphic page and for temporary or short term trending of data where the trend data is not stored at the controller level.
61. Portable Operators Terminal (POT): Laptop PC used both for direct connection to a controller and for remote dial up connection.
62. Protocol Implementation Conformance Statement (PICS): A written document, created by the manufacturer of a device, which identifies the particular options specified by BACnet that are implemented in the device.
63. Repeater: A physical device used to connect two segments while amplifying, conditioning, or strengthening the signal. A Repeater does not provide any routing or filtering of network traffic.
64. Router: A device which routes or forwards messages destined for a node on another subnet or domain of the DLN. The device controls message traffic based on node address and priority. Routers also serve as communication interfaces between power line, twisted pair and RF media.
65. RS-232: EIA/TIA-232 Standard
66. RS-485: EIA/TIA-485 Standard

67. Secure Socket Layer (SSL): A commonly used protocol for managing the security of messages transmission on the Internet.
68. Server: A device that is a provider of services to a client. A client device makes requests of and receives responses from a server device.
69. Simple Object Access Protocol (SOAP): A method for a program running in one type of operating system to communicate with a program on the same or different type of operating system by using the World Wide Web's Hyper Text Transfer Protocol (HTTP) and its Extensible Markup Language (XML) as the mechanisms for information exchange.
70. Slave Devices: Slave devices cannot initiate requests for data; they can reply only to messages from other devices. They are best suited for simple, low-cost functions.
71. Smart Device: A control I/O device such as a sensor or actuator that can directly communicate with the controller network to which it is connected.
72. Solenoid: Electric two-position actuator.
73. Structured Query Language (SQL): A standard interactive and programming language for retrieving information from and for updating a database via an organized series of queries.
74. Stand-Alone Controller: A stand-alone controller has provisions for all of the physical inputs and physical outputs associated with a single mechanical component such as a terminal unit, air handling unit, chiller or boiler. The controller shall also have embedded in it all of the control logic that associated the physical inputs to the physical outputs. A stand-alone controller may rely on other networked devices for time schedule inputs and trend data storage.
75. Supervisory Control and Data Acquisition (SCADA) Node: An MMI incorporating a graphical object-oriented user interface software application which provides supervisory control and data acquisition from a high level processing personnel computer.
76. Supervisory Logic: The concept of gathering performance data from multiple terminal units to determine if a specific condition exists within the family of terminal devices.
77. Terminator: An electric component that consists of a resistive and capacitive circuit specifically designed to enhance the quality of communication on a segment. On a bus topology, terminators are connected to both ends of a segment. On MS/TP and free topology network segments a single terminator is required. The terminator is placed at the end-of-line for the MS/TP network segment.
78. Trend Log: A trend log is a collection of samples from a specified variable that are stored within a device on the IAS Network. This data may be periodically sent up to or requested by a Network Controller or an Operator Workstation for the purpose of report generation.
79. UUKL Listing: Underwriter's Laboratory UL 864 Listed, 9th Edition, UUKL Smoke Control System.
80. WAN: Wide Area Network - Internet-based network connecting multiple facilities with a central data warehouse and server, accessible via standard web-browser.
81. XML (Extensible Markup Language): A specification developed by the World Wide Web Consortium. XML is a pared-down version of SGML, designed especially for Web documents. It allows designers to create their own customized tags, enabling the definition, transmission, validation, and interpretation of data between applications and between organizations.

1.9 Abbreviations

1.	AHU	Air Handling Unit
2.	AI	Analog Input
3.	ANSI	American National Standards Institute

4.	AO	Analog Output
5.	Approx.	Approximately
6.	ASC	Application Specific Controller
7.	ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers
8.	ASPE	American Society of Plumbing Engineers
9.	ASME	American Society of Mechanical Engineers
10.	ASTM	American Society for Testing and Materials
11.	ATC	Automatic Temperature Control System
12.	AWG	American Wire Gauge (Standard)
13.	EMCS	Building Automation System
14.	BMS	Building Management System
15.	BOS	Building Operations Server
16.	CAD	Computer Aided Design
17.	Contr.	Contractor
18.	COS	Change of State
19.	CPU	Central Processing Unit
20.	CRAC	Computer Room Air Conditioning
21.	CRT	Cathode Ray Tube
22.	DALI	Digital Addressable Lighting Interface
23.	DDC	Direct Digital Controls
24.	Deg. F or °F	Degree Fahrenheit
25.	DI	Discrete or Digital Input
26.	Dia. or diam.	Diameter
27.	DMA	Direct Memory Access
28.	DO	Discrete or Digital Output
29.	Dwgs.	Drawings
30.	EP	Electric-pneumatic
31.	EMCS	Energy Management Control System
32.	FAC LAN	Facility Local Area Network
33.	FPB	Fan powered (VAV) box
34.	FPM	Feet per minute
35.	FACP	Fire Alarm Control Panel
36.	FCC	Fire Command Center
37.	FCIP	Firefighters' Control and Indicating Panel
38.	FMS	Facility Management System
39.	Galv.	Galvanized
40.	GUI	Graphical User Interface

41.	HVAC	Heating Ventilating and Air Conditioning
42.	IAS	Integrated Automation System
43.	I/O	Input / Output
44.	ISA	Intelligent Sensor or Actuator
45.	LCU	Local Control Unit
46.	NCU	Network Controller Unit
47.	NSS	Network Services Server
48.	NSI	Network Services Interface
49.	Mfr.	Manufacturer
50.	Max.	Maximum
51.	Min.	Minimum or Minute
52.	MMI	Man-Machine Interface
53.	MSCP	Mass Storage Control Protocol
54.	MSI	Master System Integrator
55.	NCP	Network Control Panel
56.	NEC	National Electrical Code
57.	NI	Network Integrator
58.	NIC	Not in Contract
59.	NFPA	National Fire Protection Association
60.	O.C.	On Center
61.	O.D.	Outside Diameter
62.	OS	Operating System
63.	PE	Pneumatic-electric
64.	Per	According to, in accordance with
65.	PRV	Pressure Reducing Valve
66.	Provide	Furnish and install
67.	RAM	Random Access Memory
68.	ROM	Read Only Memory
69.	RTD	Resistance Temperature Device
70.	SCADA	Supervisory Control and Data Acquisition System
71.	SI	Systems Integrator
72.	SNVT	Standard Network Variable Type
73.	TCP/IP	Transmission Control Protocol / Internet Protocol
74.	TCU	Terminal Control Unit
75.	THHN	Thermoplastic High Heat Resistant Nylon Coated-Cable coating
76.	TP	Twisted Pair
77.	UBC	Uniform Building Code
78.	UL	Underwriters' Laboratory

79.	UMC	Uniform Mechanical Code
80.	UML	Unified Modeling Language
81.	UPS	Uninterruptible Power Supply
82.	VAV	Variable Air Volume
83.	VCS	Voice Communication System
84.	VFD	Variable Frequency Drive
85.	XML	Extensible Markup Language

1.10 Quality Assurance

A. All new building automation system products on this project shall be provided by a firm that is a registered ISO 9001:2000 manufacturer at time of bid.

B. The IAS shall be furnished, engineered, installed, tested and calibrated by factory certified technicians qualified for this work. The Systems Integrator shall be Factory Authorized in good standing with the Manufacturer. Factory trained technicians shall provide instruction, routine maintenance, and emergency service within 24 hours upon receipt of request.

C. Upon request, installer shall present records of successful completion of factory training courses including course outlines.

D. Upon request the installer shall provide a letter from the manufacturer that they are Factory Authorized in good standing.

1. All microprocessor-based control products used shall conform to BTL Certified Standards.

E. For equipment types that certified devices do not exist, another interface to that equipment must be provided upon approval of the Architect/Engineer.

F. It is the Contractor's responsibility to verify that the equipment manufacturers provide the appropriate interface boards as defined in these specifications and design drawings.

G. The contractor shall provide hardware and software components of the same manufacturer wherever possible.

H. The contractor shall use standard off-the-shelf components and/or products whenever possible. Custom products shall not be used unless approved prior to the installation.

I. Materials and equipment shall be catalogued products and shall be manufacturer's latest standard design that complies with the specification requirements. Where multiple units of the same type or function are required for this project, these units shall be products of a single manufacturer.

J. All equipment shall be manufactured, installed and tested to comply with the acceptance testing requirements specified herein.

K. Product Line Demonstrated History: The product line being proposed for the Project must have an installed history of demonstrated satisfactory operation for a length of one (1) year since date of final completion in at least ten (10) installations of comparative size and complexity.

1. Submittals shall document this requirement with references.

L. The IAS and components shall be listed by Underwriters Laboratories (UL 916) as an Energy Management System.

M. The IAS components, used to implement smoke control strategies, shall be UUKL listed.

1.11 IAS Installer's Qualifications

A. IAS Installer to:

1. Have local office within 100 miles of project for at least 5 years, staffed by trained personnel capable of providing instruction, routine maintenance and emergency service on systems.

2. Provide record of successful installations of similar size, performed by Systems Integrator submitting the tender, showing successful experience with similar computer-based systems.
3. Have in-house staff with expertise in pneumatic controls where applicable.
4. Provide Profiles for each employee who will be involved in this project.

1.12 System Architecture

A. The system provided shall incorporate hardware and software resources sufficient to meet the functional requirements of these Specifications.

B. The DLN shall be based on industry standard open platforms as specified herein and utilize commonly available operation, management and application software.

C. All software packages shall be licensed to the Owner to allow unrestricted maintenance and operation of the IAS.

D. Contractor shall include all items not specifically itemized in these Specifications that are necessary to implement, maintain, and operate the system in compliance with the functional intent of these Specifications, including but not limited to:

1. Network Operating software
2. Device Drivers and Plug-ins
3. File Server Software
4. Graphical User Interface (GUI) and Utility software
5. Network Management, Configuration, Controller/System Programming and Utility software
6. Original electronic media and licenses for all software packages utilized to implement the IAS

E. The system architecture for the campus-wide IAS consists of an Ethernet-based Local Area Network (LAN) with existing Enterprise Level Server that supports multiple Building Operation Server integration. The following indicates a functional description of the existing campus-wide structure:

1. Facility Local Area Network (FAC LAN): The FAC LAN shall be an Ethernet-based, 10/100/1000 Ethernet LAN.
2. The FAC LAN serves as the backbone for the BOSs communications path to Enterprise Level Server and to Peer Building Operations Servers.
3. LAN shall be IEEE 802.3 Ethernet over Fiber or Category 6 cable with switches and routers that support 1000 base-T gigabit Ethernet throughput.
4. The FAC LAN shall be installed in accordance with IEEE 802.3, TIA/EIA 568-B and TIA/EIA 569-A.
5. The FAC LAN shall be provided by others.

F. The system architecture for the building-level IAS shall consist of an Ethernet-based Device Level Network (DLN), connecting Building Operations Servers (BOS) to Equipment Controllers (EC) and Terminal Controllers (TC). The following indicates a functional description of the building level structure. The contractor shall utilize these components of the IAS for the scope of this project:

1. Device Level Network (DLN): The DLN shall be an Ethernet-based, 10/100/1000 Ethernet LAN.
2. The DLN serves as the backbone for the BOSs communications path to ECs and TCs.
3. DLN shall be IEEE 802.3 Ethernet over Fiber or Category 6 cable with switches and routers that support 1000 base-T gigabit Ethernet throughput.
4. The DLN shall be installed in accordance with IEEE 802.3, TIA/EIA 568-B and TIA/EIA 569-A.

5. The DLN shall be provided by the contractor.

G. Dynamic Data Access: Data throughout any level of the LAN or DLN shall be available to and accessible by all other devices, Controllers and OWS, whether directly connected or connected remotely as defined in the point list schedules.

H. Remote Data Access: The system shall support Internet Browser-based remote access to the building data.

I. Browser-based access: A remote/local user using a standard browser will be able access all control system facilities and graphics via the LAN or direct connection, with proper username and password.

1. Only Internet browser-based user interfaces (HTML5, Java, XML, CCS3 JAVA Script, etc.) are acceptable.

J. The Web browser software shall run on any operating system and system configuration that is supported by the Web browser.

K. The Web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Graphical User Interface.

1. Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.

L. The communication speed between the controllers, DLN interface devices, BOS and operator interface devices shall be sufficient to ensure fast system response time under any loading condition. Contractor shall submit guaranteed response times with Shop Drawings including calculations to support the guarantee. In no case shall delay times between an event, request, or command initiation and its completion be greater than those listed herein. Contractor shall reconfigure LAN as necessary to accomplish these performance requirements:

1. 5 seconds between a Level 1 (critical) alarm occurrence and enunciation at operator workstation.
2. 10 seconds between a Level 2 alarm occurrence and enunciation at operator workstation.
3. 20 seconds between a Level 3 to 5 alarm occurrence and enunciation at operator workstation.
4. 10 seconds between an operator command via the operator interface to change a setpoint and the subsequent change in the controller.
5. 5 seconds between an operator command via the operator interface to start/stop a device and the subsequent command to be received at the controller.
6. 10 seconds between a change of value or state of an input and it being updated on the operator interface.
7. 10 seconds between an operator selection of a graphic and it completely painting the screen and updating at least ten (10) points.

M. The Operator Interface shall provide for overall system supervision, graphical user interface, management report generation, alarm annunciation, and remote monitoring. The system shall be capable of supporting an unlimited number of clients using a standard Web browser such as Internet Explorer™, FireFox™ or Chrome™.

N. The Equipment Controllers (EC) and Terminal Controllers (TC) shall monitor, control, and provide the field interface for all points specified. Each EC and TC shall be capable of performing all specified energy management functions and all DDC functions, independent of other ECs and TCs and operator interface devices.

1. The ECs and TCs used to implement smoke control strategies shall be UUKL listed.

O. User tools for DLN management shall be provided and licensed to the Owner and shall allow unrestricted configuring, updating, maintaining and expanding of all devices, configurations and settings.

P. All line drivers, signal boosters, and signal conditioners etc. shall be provided as necessary for proper data communication.

1.13 Delivery, Storage and Handling

A. Provide factory-shipping cartons for each piece of equipment and control device. Maintain cartons during shipping, storage and handling as required to prevent equipment damage, and to eliminate dirt and moisture from equipment. Store equipment and materials inside and protect from weather.

1.14 Warranty

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace products that fail in materials or workmanship within specified warranty period.

1. Failures shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner.
2. Include updates or upgrades to software and firmware if necessary to resolve deficiencies.
   a. Install updates only after receiving Owner's written authorization.
3. Warranty service shall occur during normal business hours and commence within 24 hours of Owner's warranty service request.
4. In the last month of the Warranty Period, all System software and controller firmware, software, drivers, etc. will be upgraded to the latest release (version) in effect at the end of the Warranty Period. Provide the owner with a 5-year option for software upgrade maintenance services
5. Warranty Period: One year from date of Substantial Completion.

1.15 Owner Furnished Equipment

A. Owner furnished controls equipment shall include the following:

1. Building Operations Server with Operating System and UPS.
2. [Enter Quantity] Distech ECY-S1000 Large Equipment Controllers with the following Expansion Modules:
   a. [Enter Quantity] Distech ECY-PS24 Power Modules
   b. [Enter Quantity] Distech ECY-RS485 Communications Modules
   c. [Enter Quantity] Distech ECY-8UI6UO-HOA I/O Modules
   d. [Enter Quantity] Distech ECY-8DOR-HOA I/O Modules
3. [Enter Quantity] Distech ECY-303 Medium Equipment Controllers
4. [Enter Quantity] Distech ECY-TU-203 Small Equipment Controllers
5. [Enter Quantity] Distech ECY-VAV (Plenum Rated) VAV Controllers

B. Owner furnished network equipment shall include the following:

1. [Enter Quantity] Optigo ACC-PS-48V300W Power Supplies
2. (1) Optigo ONS-NC-600 Network Controller
3. [Enter Quantity] Optigo ONC-CD0840GP Aggregation/Operations Switches

C. Application software and programming for all owner furnished controllers shall be provided by contractor.

PART 2 - PRODUCTS

2.1 Manufacturers

A. Furnish building automation system components supplied by a company regularly engaged in the manufacturing and distribution of building automation systems. The BAS Manufacturer shall meet the following qualifications as a minimum:

1. The manufacturer of the hardware and software components must be primarily engaged in the manufacture of building automation systems as specified herein, and must have been so for a minimum of five (5) years.

B. Product Manufacturers

1. Distech Controls

C. Materials and Equipment

1. Materials shall be new, the best of their respective kinds without imperfections or blemishes, and shall not be damaged in any way.
2. Used equipment shall not be used in any way for the permanent installation except where Drawings or Specifications specifically allow existing materials to remain in place.

D. Uniformity

1. To the extent practical, all equipment of the same type serving the same function shall be identical and from the same manufacturer.

2.2 IAS Integrators/Installers

A. Provide a fully functioning building automation system as defined in this specification and related documents. The system integrator shall meet the following qualifications as a minimum.

1. The system integrator of the hardware and software components must be primarily engaged in the installation/integration building automation systems as specified herein, and must have been so for a minimum of five (5) years.
2. The system integration firm must be factory trained and certified by the product manufacturer.
3. Approved System Integrators
   a. Alabama Controls inc. DBA Albireo Energy LLC
   b. CSUSA Mid-South Controls
   c. Engineered Cooling Services

PART 3 - EXECUTION

3.1 Preparation

A. Examine areas and conditions under which control systems are to be installed. Do not proceed with Work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

B. These specifications call out certain duties of the Contractor and any subcontractor(s). They are not intended as a material list of all items required by the Contract.

3.2 Installation

A. General Installation Requirements:

1. Utilize licensed electricians for all new and retrofitted electrical distribution systems. Installations of high and low voltage systems shall be in accordance with all building code requirements. Obtain electrical permits, if required by local authorities.

2. Provide related items and work indicated on the IAS Drawings and items and work called for in this Division of the Specifications.
3. This includes all incidentals, equipment, appliances, services, hoisting, scaffolding, supports, tools, supervision, labor, consumable items, fees, licenses, etc., necessary to provide complete systems.
4. Perform start up, configuration, programming and commissioning coordination on each control product and system to provide fully operable systems in accordance with the specified functional performance.
5. Comply with Federal, State, Municipal and other applicable codes and ordinances. If any conflict arises between these Specification and Drawings, and codes and ordinances, immediately notify the Owner's Representatives. Do not deviate from the Drawings and Specifications nor install any work which may be in conflict with codes and ordinances until the conflict is resolved and the solution accepted by the Owner.
6. The IAS Drawings show the general arrangement of the respective systems.
7. Follow these Drawings as closely as actual building construction and the work of other trades will permit.
8. Provide devices, fittings, sensors, controllers, wiring and accessories, which may be required but are not shown on the Drawings or specified herein.
9. The Contractor shall be responsible for achieving the sequence of operations and intent of the system design.
10. Investigate conditions affecting the work and arrange the work accordingly. Provide modifications and accessories as may be required to meet such conditions.
11. All installation shall be in accordance with manufacturer's published recommendations.
12. Limit LAN and DLN cable lengths to no longer than 80% of the longest dimension published by the manufacturer of the cable between the most remote network nodes.
13. Install products level, plumb, parallel, and perpendicular with building construction.
14. Support products, tubing, piping wiring and raceways.
15. Fabricate openings and install sleeves in ceilings, floors, roof, and walls required by installation of products. Before proceeding with drilling, punching, and cutting, check for concealed work to avoid damage. Patch, flash, grout, seal, and refinish openings to match adjacent condition.
16. Firestop penetrations made in fire-rated assemblies.
17. Fastening Hardware:
    a. Stillson wrenches, pliers, and other tools that damage surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening fasteners.
    b. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
    c. Lubricate threads of bolts, nuts and screws with graphite and oil before assembly.
18. If product locations are not indicated, install products in locations that are accessible and that will permit service and maintenance from floor, equipment platforms, or catwalks without removal of permanently installed furniture and equipment.

3.3 Controller Quantity and Location

A. Equipment Controllers (EC) and Terminal Controllers (TC) are referenced to indication allocation of control points to each controller and controller location.

B. Where an EC or TC is referenced, a minimum of one control device, and additional devices as required, shall be provided to meet the requirements of this Specification. Contractor shall provide power to devices from an acceptable power source. Contractor is responsible for ensuring that devices are located to not interfere with other requirements of the Project and maintain adequate clearance for maintenance access.

C. Contractor shall locate ECs and TCs as referenced on plans. It is the Contractor's responsibility to provide enough controllers to ensure a completely functioning system, according to the point list and sequence of operations.

D. Contractor shall provide a minimum of the following:

1. [One EC for each air handler located in applicable mechanical room]
2. [One DCP (including at least one controller) for each critical fan system]
3. [One DCP (including at least one controller) for each CRAC system]
4. [One DCP (including at least one controller) for each ATS]
5. [One DCP (including at least one controller) for each lighting system]
6. [One DCP (including at least one controller) for each stair pressurization fan system]
7. [One controller for each piece of terminal equipment, to be located at the equipment (e.g. VAV box)]

3.4 Network Management Functional Requirements

A. The Contractor shall coordinate the setup and configuration of the IAS local area network hardware to permit the functional requirements of the IAS herein specified. The setup shall include as a minimum, the following network management procedures:

1. Automatic backup of the DDC System database to appropriate media.
2. Program, load and debug all software installations.
3. Network user auditing routine.

3.5 Surge Protection

A. Contractor shall furnish and install any power supply surge protection, filters, etc. as necessary for proper operation and protection of all controllers and field devices. All equipment shall be capable of handling voltage variations 10 percent above or below measured nominal value, with no effect on hardware, software, communications, and data storage.

3.6 Control Power Source and Supply

A. IAS Contractor shall extend all power source wiring required for operation of all equipment and devices provided under Division 25 and the Drawings.

B. General requirements for obtaining power include the following:

1. In the case where additional power is required, obtain power from a source that feeds the equipment being controlled such that both the control component and the equipment are powered from the same panel. Where equipment is powered from a 480V or 600V source, obtain power from the electrically most proximate 120v source fed from a common origin.
2. Where control equipment is located inside a new equipment enclosure, coordinate with the equipment manufacturer and feed the control with the same source of power as the equipment. If the equipment's control transformer is large enough and is the correct voltage to supply the controls, it may be used. If the equipment's control transformer is not large enough or of the correct voltage to supply the controls, or is too noisy for reliable control, provide a separate transformer.

3. Where a controller controls multiple systems on varying levels of power reliability (normal, emergency, and/or interruptible), the controller shall be powered by the highest level of reliability served.

3.7 Product Delivery, Storage, Handling, Protection and Cleaning

A. All products and materials shall be new, clean, and free of defects, damage and corrosion.

B. Ship and store products and materials in a manner which will protect them from damage, weather, and entry of debris. Do not install damaged items - take immediate steps to obtain replacement or repair.

C. The Contractor shall provide adequate means for and shall fully protect all finish parts of the materials and equipment against damage from any cause during the progress of the work until final acceptance. All materials and equipment in storage and during construction shall be covered in such a manner that no finished surfaces will be damaged or marred, and all moving parts shall be kept clean and dry. The Contractor is responsible for providing storage of materials and equipment.

D. Equipment and accessories shall be thoroughly cleaned of cement, plaster, and other materials; grease and oil spots shall be removed with cleaning solvent and surfaces carefully wiped.

E. Panels housing electronic controllers shall be constructed so that the panel and associated wiring may be installed independent of the installation of the electronics. The installation of electronics shall be coordinated with other trades and construction schedules to avoid damage.

3.8 Identification

A. Control Equipment, Instruments, and Control Devices:

1. Engraved tag bearing unique identification.

    a. Include instruments with unique identification identified by equipment being controlled or monitored, followed by point identification.

2. Tag shall consist of white lettering on black background.

3. Tag shall be engraved phenolic consisting of three layers of rigid laminate. Top and bottom layers are color-coded black with contrasting white center exposed by engraving through outer layer.

4. Tag shall be fastened with drive pins.

5. Instruments, control devices and actuators with Project-specific identification tags having unique identification numbers following requirements indicated and provided by original manufacturer do not require an additional tag.

B. Raceway and Boxes:

1. Comply with requirements for identification specified in Division 26 "Identification for Electrical Systems."

2. Paint cover plates on junction boxes and conduit same color as the tape banding for conduits. After painting, label cover plate "Building Controls," using an engraved phenolic tag.

Section 25 05 02 – Integrated Automation System Submittals

PART 1 - GENERAL

1.1 Related Sections

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Section 25 05 01, Integrated Automation System General Requirements

C. Section 25 05 03, Integrated Automation System Project Record Documents

D. Section 25 05 04, Integrated Automation System Start-Up, Verification and Commissioning

E. Section 25 05 05, Integrated Automation System Training

F. Section 25 10 01, Integrated Automation System Networks

G. Section 25 10 02, Integrated Automation System Computer Systems, MMI

H. Section 25 30 01, Integrated Automation System Field Controllers

I. Section 25 35 13, Integrated Automation System Actuators and Operators

J. Section 25 35 16, Integrated Automation System Sensors and Transmitters

K. Section 25 35 19, Integrated Automation System Control Valves

L. Section 25 35 27, Integrated Automation System Variable Frequency Drives

M. Section 25 35 30, Integrated Automation System Tubing, Cabling and Raceway

1.2 Submittals

A. General: See Division 1 specifications for general submittal requirements.

B. Functional Intent: Throughout the Contract Documents, detailed requirements are specified, some of which indicate a means, method or configuration acceptable to meet that requirement.

1. Contractor may submit products that utilize alternate means, methods, and configurations that meet the functional intent - these will only be allowed with prior approval.

C. Electronic Submittals: While all requirements for hard copy submittal apply, IAS control submittals and operation and maintenance (O&M) information shall also be provided in electronic format as follows:

1. Drawings and Diagrams: Shop Drawings shall be provided on electronic media in Visio file format.

2. Other Submittals: All other submittals shall be provided in Adobe Document Format

3. Qualifications: Manufacturer, Installer, and Key personnel qualifications as indicated for the appropriate items.

a. Submit a list of no less than five similar projects, which utilize the Enterprise connectivity to provide an Integrated Automation System that consists of web-browser control and monitoring of the proposed field level devices.

b. These projects must be on-line and functional such that representatives from the Owner can observe the Integrated Automation System and Interface in full operation. Include proper references and contact numbers of these reference projects.

c. Submit validation which indicates the successful completion of the required certification course(s).

d. Submit resumes of installing staff indicating passing certificates for training on the line of controls to be installed as part of this project. Also include prior Instrumentation and Control experience.

e. Submit an organizational diagram indicating the key technical staff proposed for the project including Project Manager, Application Engineer, Programmers, Superintendent, Electrical Foreman, Electricians, and Technicians etc.

f. Provide staff quantities to be assigned to the project. Provide contact information for Managers, Programmers, and Lead Technicians upon acceptance of bid.

g. Submit a record of the number of personal employed by the System Integrator.

h. This submittal shall clearly indicate the number of managers, technicians, electricians, and programmers certified in the line of DDC controls represented and certified in graphical user interface development and system network management.

i. Also indicate the number of staff that will be assigned to this project.

j. Provide certifications of all employed personal trained and certified by an Enterprise Network Infrastructure manufacturer for GUI integration and development.

k. Identify the number of integrators to be assigned to this project.

l. The Contractor shall indicate the duration, in which the company has represented the line of controls proposed for this project.

m. The Contractor shall also disclose all previous manufactures that have been or currently are represented over the last seven (7) years.

n. GUI development software

1) Provide screen captures of graphical user interfaces developed by the Contractor on previous projects. These screen shots shall represent work performed by the contractor and not of the company from the line of controls which the Contractor represents. Provide client contact information for the Owner to validate.

4. Product Data: Submit manufacturer's technical product data for each Network Control Unit, control device, panel, and accessory furnished, indicating dimensions, capacities, performance and electrical characteristics, and material finishes. Also include installation and start-up instructions.

5. Products: Submit for acceptance a list of all material and equipment manufacturers whose products are proposed, as well as names of all subcontractors whom the Contractor proposes to employ.

a. Provide a list of devices in schedule form on 8½ x 11 sheets. The schedule shall be organized by columns to define all new devices to be installed as part of the EMCS system including the location, system served, controlling unit, model number, performance data, size, range, accuracy, span, operating pressure, etc.

b. Submit documentation indicating BTL compliance and include Protocol Implementation Conformance (PIC) Statements. All PIC statements, product literature, and standard configuration parameters shall be compiled and submitted on electronic media for the following.

1) Building Operations Server (BOS) – Software Only

2) Intelligent Sensors and Actuators

3) Equipment Controllers (EC)

4) Terminal Controllers (TC)

5) Application Specific Controllers

6) Interface Panels

7) Network Management Equipment (Routers, Protocol Analyzers, etc.)

c. Submit detailed cut sheets indicating the features, accessories and sub-assemblies of the following, or similar as required:

1) All ancillary devices including temperature sensors, flow sensors, and the like, including thermal wells where necessary

2) Pressure gauges, thermometers and indicating devices where shown on the drawings

3) Transformers required for control devices

4) Relays

5) Electrical enclosures and back-plates

6) Wire for DLN, and all sensors and actuators

7) Hub(s), Switches, and Routers

8) DLN Repeaters

9) Gateway and interface devices

10) Network Management Utility Software

11) Application Programming Tools/Software (DDC controller programming software)

12) Interface devices

13) Web based configuration and programming for control devices

6. Shop Drawings: For each control system, including a complete drawing for each controller identified in the IAS drawings with all point descriptors, addresses and point names indicated. Include mounting details and power supplies. Shop Drawings shall contain the following information:

7. System Architecture and System Layout:

a. One-line diagram indicating how the new network controller units will integrate with the IAS field level devices.

b. Provide floor plans locating the BOS, ECs and TCs, workstations, servers, DLN interface devices, etc.

c. Include all DLN communication wiring routing, power wiring, power originating sources, and low voltage power wiring. Indicate network number, device ID, MAC address, device instance, drawing reference number, and controller type for each device.

d. Indicate media, protocol and type of each DLN segment.

e. All controllers, sensors located in finished areas, I/O devices installed in mechanical systems, repeaters, end-of-line resistors, other IAS related components, sensors and actuators, etc. shall be located on the floor plans.

f. Wiring routing and as-built conditions shall be maintained accurately throughout the construction period and the drawing shall be updated to accurately to reflect actual installed conditions.

g. Schematic flow diagram of each air system showing fans, coils, dampers, valves, and control devices. Include written description of sequence of operation.

h. All physical and logical points on the schematic flow diagram shall be indicated with names, descriptors, and point addresses as identified in the point list schedule.

i. With each schematic, provide a point summary table listing building number and abbreviation, system type, equipment type, full point name, point description, Ethernet

backbone network number, network number, device ID, object ID (object type, instance number).

j. Label each control device with setting or adjustable range of control.

k. Label each input and output with the appropriate range.

l. Provide a Bill of Materials with each schematic. Indicate device identification to match schematic and actual field labeling, quantity, actual product ordering number, manufacturer, description, size, voltage range, pressure range, temperature range, etc. as applicable.

m. With each schematic, provide valve and actuator information including size, Cv, design flow, design pressure drop, manufacturer, model number, close off rating, etc. Indicate normal positions of spring return valves and dampers

n. Provide detailed schematics for interface connections including installation and commissioning specifics. Include detailed terminal interconnect diagrams for connecting to equipment manufacture's integral communications boards.

o. Indicate all required electrical wiring.

p. Electrical wiring diagrams shall include both ladder logic type diagram for motor starter, control, and safety circuits and detailed digital interface panel point termination diagrams with all wire numbers and terminal block numbers identified.

q. Provide panel termination details on separate Drawings. Ladder diagrams shall appear on system schematic.

r. Clearly differentiate between portions of wiring that exists, factory-installed and portions to be field-installed.

s. Provide details for wiring color code assignment.

t. Provide details of control panels, including controls, instruments, and labeling shown in plan or elevation indicating the installed locations.

u. Sheets shall be consecutively numbered.

v. Each sheet shall have a title indicating the type of information included and the system type controlled.

w. Table of Contents listing sheet titles and sheet numbers.

x. Legend and list of abbreviations

y. Submit in Schedule format a detailed list of all spare parts to be provided per the contract documents.

8. Control Logic Documentation

a. Include written description of each control sequence.

b. Include control response, settings, and setpoints, throttling ranges, gains, reset schedules, adjustable parameters and limits as part of as-built documentation.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

Section 25 05 03 – Integrated Automation System Project Record Documents

PART 1 - GENERAL

1.1 Related Sections

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Section 25 05 01, Integrated Automation System General Requirements

C. Section 25 05 02, Integrated Automation System Submittals

D. Section 25 05 04, Integrated Automation System Start-Up, Verification and Commissioning

E. Section 25 05 05, Integrated Automation System Training

F. Section 25 10 01, Integrated Automation System Networks

G. Section 25 10 02, Integrated Automation System Computer Systems, MMI

H. Section 25 30 01, Integrated Automation System Field Controllers

I. Section 25 35 13, Integrated Automation System Actuators and Operators

J. Section 25 35 16, Integrated Automation System Sensors and Transmitters

K. Section 25 35 19, Integrated Automation System Control Valves

L. Section 25 35 27, Integrated Automation System Variable Frequency Drives

M. Section 25 35 30, Integrated Automation System Tubing, Cabling and Raceway

1.2 Record Documents

A. Provide record copies of product data and control Shop Drawings updated to reflect the final installed condition.

B. Provide record copies of control logic sequences. Accurately record actual setpoints and settings of controls, final sequence of operation, including changes to programs made after submission and approval of Shop Drawings and including changes to programs made during specified testing.

C. Provide as-built network architecture Drawings showing all nodes including a description field with specific controller identification, description and location information.

D. Record copies shall include individual floor plans with controller locations with all interconnecting wiring routing including space sensors, LAN wiring, power wiring, low voltage power wiring. Indicate device instance, logical address and drawing reference number.

E. Provide record riser diagram showing the location of all controllers.

F. Maintain Project record documents throughout the Warranty Period and submit final documents at the end of the Warranty Period.

G. Record copies and as-built documentation to be submitted electronically in Visio format.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

Section 25 05 04 – Integrated Automation System Start-Up and Verification

PART 1 - GENERAL

1.1 Related Sections

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Section 25 05 01, Integrated Automation System General Requirements

C. Section 25 05 02, Integrated Automation System Submittals

D. Section 25 05 03, Integrated Automation System Project Record Documents

E. Section 25 05 05, Integrated Automation System Training

F. Section 25 10 01, Integrated Automation System Networks

G. Section 25 10 02, Integrated Automation System Computer Systems, MMI

H. Section 25 30 01, Integrated Automation System Field Controllers

I. Section 25 35 13, Integrated Automation System Actuators and Operators

J. Section 25 35 16, Integrated Automation System Sensors and Transmitters

K. Section 25 35 19, Integrated Automation System Control Valves

L. Section 25 35 27, Integrated Automation System Variable Frequency Drives

M. Section 25 35 30, Integrated Automation System Tubing, Cabling and Raceway

1.2 Commissioning

A. Reference the following Sections for Commissioning Requirements:

1. Section 01 91 13, General Commissioning Requirements
2. Section 23 08 00, Commissioning of Mechanical Systems
3. Section 26 08 00, Commissioning of Electrical Systems

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 Pre-Installation Quality Control

A. Pre-Installation Programming, Configuration and Testing

1. Equipment Controllers (EC) and Terminal Controllers (TC) shall be programmed, configured and tested prior to installation.
   a. Programming, configuration and testing to be performed at Contractor's premises.
   b. I/O testing may be performed using software simulated inputs and outputs.
2. Owner Furnished Building Operations Server (BOS) will be made available for contractor use within 30 calendar days following issue of LOI.
3. Contractor to install and configure specified software on BOS prior to installation.

3.2 IAS Field Quality Control

A. Commissioning: See Commissioning Specification Sections for testing details.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and installations, including connections.

C. Perform the following tests and inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

D. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Testing:

1. Perform preinstallation, in-progress, and final tests, supplemented by additional tests, as necessary.

2. Preinstallation Cable Verification: Verify integrity and serviceability for new cable lengths before installation. This assurance may be provided by using vendor verification documents, testing, or other methods. As a minimum, furnish evidence of verification for cable attenuation and bandwidth parameters.

3. In-Progress Testing: Perform standard tests for correct pair identification and termination during installation to ensure proper installation and cable placement. Perform tests in addition to those specified if there is any reason to question condition of material furnished and installed. Testing accomplished is to be documented by agency conducting tests. Submit test results for Project record.

4. Final Testing: Perform final test of installed system to demonstrate acceptability as installed. Testing shall be performed according to a test plan supplied by DDC system manufacturer. Defective Work or material shall be corrected and retested. As a minimum, final testing for cable system, including spare cable, shall verify conformance of attenuation, length, and bandwidth parameters with performance indicated.

5. Fiber-Optic System Test Equipment: Use a fiber-optic time domain reflectometer for testing of length and optical connectivity (where applicable).

6. Test Results: Record test results and submit copy of test results for Project record.

3.3 IAS System I/O Checkout Procedures

A. Check installed products before continuity tests, leak tests and calibration.

B. Check instruments for proper location and accessibility.

C. Check instruments for proper installation on direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.

D. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material and support.

E. For pneumatic products, verify that air supply for each product is properly installed.

F. Control Damper Checkout:

1. For pneumatic dampers, verify that pressure gages are provided in each air line to damper actuator and positioner.

2. Verify that control dampers are installed correctly for flow direction.

3. Verify that proper blade alignment, either parallel or opposed, has been provided.

4. Verify that damper frame attachment is properly secured and sealed.

5. Verify that damper actuator and linkage attachment is secure.

6. Verify that actuator wiring is complete, enclosed and connected to correct power source.

7. Verify that damper blade travel is unobstructed.

G. Control Valve Checkout:

1. For pneumatic valves, verify that pressure gages are provided in each air line to valve actuator and positioner.
2. Verify that control valves are installed correctly for flow direction.
3. Verify that valve body attachment is properly secured and sealed.
4. Verify that valve actuator and linkage attachment is secure.
5. Verify that actuator wiring is complete, enclosed and connected to correct power source.
6. Verify that valve ball, disc or plug travel is unobstructed.
7. After piping systems have been tested and put into service, but before insulating and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks. Replace the valve if leaks persist.

H. Instrument Checkout:

1. Verify that instrument is correctly installed for location, orientation, direction and operating clearances.
2. Verify that attachment is properly secured and sealed.
3. Verify that conduit connections are properly secured and sealed.
4. Verify that wiring is properly labeled with unique identification, correct type and size and is securely attached to proper terminals.
5. Inspect instrument tag against approved submittal.
6. For instruments with tubing connections, verify that tubing attachment is secure and isolation valves have been provided.
7. For flow instruments, verify that recommended upstream and downstream distances have been maintained.
8. For temperature instruments:
   a. Verify sensing element type and proper material.
   b. Verify length and insertion.

3.4 IAS System I/O Adjustment, Calibration and Testing

A. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.

B. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.

C. For each analog instrument, make a three-point test of calibration for both linearity and accuracy.

D. Equipment and procedures used for calibration shall comply with instrument manufacturer's written instructions.

E. Provide diagnostic and test equipment for calibration and adjustment.

F. Field instruments and equipment used to test and calibrate installed instruments shall have accuracy at least twice the instrument accuracy being calibrated. An installed instrument with an accuracy of 1 percent shall be checked by an instrument with an accuracy of 0.5 percent.

G. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.

H. If after calibration indicated performance cannot be achieved, replace out-of-tolerance instruments.

I. Comply with field testing requirements and procedures indicated by ASHRAE's Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements, and to supplement requirements indicated.

J. Analog Signals:

1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.

K. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact making or breaking.

L. Control Dampers:

1. Stroke and adjust control dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
2. Stroke control dampers with pilot positioners. Adjust damper and positioner following manufacturer's recommended procedure, so damper is 100 percent closed, 50 percent closed and 100 percent open at proper air pressure.
3. Check and document open and close cycle times for applications with a cycle time less than 30 seconds.
4. For control dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

M. Control Valves:

1. Stroke and adjust control valves following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
2. Stroke control valves with pilot positioners. Adjust valve and positioner following manufacturer's recommended procedure, so valve is 100 percent closed, 50 percent closed and 100 percent open at proper air pressures.
3. Check and document open and close cycle times for applications with a cycle time less than 30 seconds.
4. For control valves equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

N. Meters: Check sensors at zero, 50, and 100 percent of Project design values.

O. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.

P. Switches: Calibrate switches to make or break contact at set points indicated.

Q. Transmitters:

1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.
2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistant source.

3.5 Final Review

A. Submit written request to Architect when DDC system is ready for final review. Written request shall state the following:

1. DDC system has been thoroughly inspected for compliance with contract documents and found to be in full compliance.
2. DDC system has been calibrated, adjusted and tested and found to comply with requirements of operational stability, accuracy, speed and other performance requirements indicated.
3. DDC system monitoring and control of HVAC systems results in operation according to sequences of operation indicated.
4. DDC system is complete and ready for final review.

B. Review by Architect shall be made after receipt of written request. A field report shall be issued to document observations and deficiencies.

C. Take prompt action to remedy deficiencies indicated in field report and submit a second written request when all deficiencies have been corrected. Repeat process until no deficiencies are reported.

D. Should more than two reviews be required, DDC system manufacturer and Installer shall compensate entity performing review for total costs, labor and expenses, associated with third and subsequent reviews. Estimated cost of each review shall be submitted and approved by DDC system manufacturer and Installer before making the review.

E. Prepare and submit closeout submittals when no deficiencies are reported.

F. A part of DDC system final review shall include a demonstration to parties participating in final review.

1. Provide staff familiar with DDC system installed to demonstrate operation of DDC system during final review.
2. Provide testing equipment to demonstrate accuracy and other performance requirements of DDC system that is requested by reviewers during final review.
3. Demonstration shall include, but not be limited to, the following:
    a. Accuracy and calibration of 10 I/O points randomly selected by reviewers. If review finds that some I/O points are not properly calibrated and not satisfying performance requirements indicated, additional I/O points may be selected by reviewers until total I/O points being reviewed that satisfy requirements equals quantity indicated.
    b. HVAC equipment and system hardwired and software safeties and life-safety functions are operating according to sequence of operation. Up to 10 I/O points shall be randomly selected by reviewers. Additional I/O points may be selected by reviewers to discover problems with operation.
    c. Correct sequence of operation after electrical power interruption and resumption after electrical power is restored for randomly selected HVAC systems.
    d. Operation of randomly selected dampers and valves in normal-on, normal-off and failed positions.
    e. Reporting of alarm conditions for randomly selected alarms, including different classes of alarms, to ensure that alarms are properly received by operators and operator workstations.
    f. Trends, summaries, logs and reports set-up for Project.
    g. For up to three HVAC systems randomly selected by reviewers, use graph trends to show that sequence of operation is executed in correct manner and that HVAC systems operate properly through complete sequence of operation including different modes of operations

indicated. Show that control loops are stable and operating at set points and respond to changes in set point of 20 percent or more.

h. Software's ability to communicate with controllers, operator workstations, uploading and downloading of control programs.

i. Software's ability to edit control programs off-line.

j. Data entry to show Project-specific customizing capability including parameter changes.

k. Step through penetration tree, display all graphics, demonstrate dynamic update, and direct access to graphics.

l. Execution of digital and analog commands in graphic mode.

m. Spreadsheet and curve plot software and its integration with database.

n. Online user guide and help functions.

o. Multitasking by showing different operations occurring simultaneously on four quadrants of split screen.

p. System speed of response compared to requirements indicated.

q. For Equipment and Terminal Controllers:

    1) Memory: Programmed data, parameters, trend and alarm history collected during normal operation is not lost during power failure.

    2) Operator Interface: Ability to connect directly to each type of digital controller with a portable operator workstation and PDA. Show that maintenance personnel interface tools perform as indicated in manufacturer's technical literature.

    3) Standalone Ability: Demonstrate that controllers provide stable and reliable standalone operation using default values or other method for values normally read over network.

    4) Electric Power: Ability to disconnect any controller safely from its power source.

    5) Wiring Labels: Match control drawings.

    6) Network Communication: Ability to locate a controller's location on network and communication architecture matches Shop Drawings.

    7) Nameplates and Tags: Accurate and permanently attached to control panel doors, instrument, actuators and devices.

Section 25 05 05 – Integrated Automation System Training

PART 1 - GENERAL

1.1 Related Sections

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Section 25 05 01, Integrated Automation System General Requirements

C. Section 25 05 02, Integrated Automation System Submittals

D. Section 25 05 03, Integrated Automation System Project Record Documents

E. Section 25 05 04, Integrated Automation System Start-Up, Verification and Commissioning

F. Section 25 10 01, Integrated Automation System Networks

G. Section 25 10 02, Integrated Automation System Computer Systems, MMI

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L. Section 25 35 27, Integrated Automation System Variable Frequency Drives

M. Section 25 35 30, Integrated Automation System Tubing, Cabling and Raceway

1.2 Training

A. Instructions

1. Provide instruction to designated personnel in adjustment, operation, maintenance and pertinent safety requirements of Integrated Automation System installed.

2. Training to be project-specific and relevant to the Integrated Automation System described in the related sections above and in the project plans/drawings.

B. Time for Training

1. Contractor to include with their project pricing a minimum of 16 hours of instructional time for owner instruction.

2. Training to occur at time and location determined by owner. Training session lengths to be at owner's discretion.

C. Training Materials

1. Provide equipment, visual/audio aids and materials for classroom training.

2. Provide as-built controls submittals in electronic format for each trainee – See Section 25 05 02 for requirements.

a. Review contents of submittals in detail to explain aspects of operation and maintenance.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

Section 25 10 01 – Integrated Automation System Networks

PART 1 - GENERAL

1.1 Related Sections

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Section 25 05 01, Integrated Automation System General Requirements

C. Section 25 05 02, Integrated Automation System Submittals

D. Section 25 05 03, Integrated Automation System Project Record Documents

E. Section 25 05 04, Integrated Automation System Start-Up, Verification and Commissioning

F. Section 25 05 05, Integrated Automation System Training

G. Section 25 10 02, Integrated Automation System Computer Systems, MMI

H. Section 25 30 01, Integrated Automation System Field Controllers

I. Section 25 35 13, Integrated Automation System Actuators and Operators

J. Section 25 35 16, Integrated Automation System Sensors and Transmitters

K. Section 25 35 19, Integrated Automation System Control Valves

L. Section 25 35 27, Integrated Automation System Variable Frequency Drives

M. Section 25 35 30, Integrated Automation System Tubing, Cabling and Raceway

1.2 Networks

A. Building Device Level Network (DLN)

1. The DLN shall be a minimum 100 Megabits/sec Ethernet network supporting BACnet, Java, XML, HTTP, SOAP, OBIX, SNMP and SMTP Protocols for maximum flexibility for integration of building data with enterprise information systems and providing support for Building Operations Server(s) (BOS), Equipment Controllers (EC) and Terminal Controllers (TC). DLN minimum physical and media access requirements:

    a. Ethernet; IEEE standard 802.3

    b. Cable; 100 Base-T, UTP-8 wire, category 6 minimum

    c. Minimum throughput; 100 Mbps

2. DLN Network Management

    a. The entire DLN shall be managed from a single point utilizing built-in software.

    b. There shall be a single login to view and manage the entire web browser-based networking system.

    c. The entire system shall be managed via single-management IP address.

    d. DLN Network Manager user interface shall be:

        1) Web Browser-Based

        2) Locally hosted on the networking equipment

        3) Displayed in graphical format

        4) Capable of supporting all required operations via point-and-click interaction

        5) Capable of supporting bulk configuration of:

            a) PoE Enable/Disable

b) VLAN Configuration/ID

c) PoE Scheduling

d) Port Status Enable/Disable

e) Port Label Text Description

f) Switch Label Text Description

g) Switch Status Enable/Disable

h) Port Security MAC Filter

i) System Name Text Description

j) System Detail Text Description

6) The GUI shall display the manufacturer name of all connected devices.

7) The user shall be able to perform a PoE reset for any individual device in the system with a single click from the GUI.

8) The tables in the GUI shall be sortable and filterable based on relevant data, including but not limited to:

a) PoE Enable

b) Text Description

c) VLAN

d) Connection Status

9) The system shall provide a backup and restore mechanism in a user editable format i.e., CSV.

10) The system shall support the ability to create a summary report with all port configurations.

11) The system shall support bulk firmware upgrades for all edge switches in one operation.

12) The system shall allow system-wide auto-creation of a VLAN simply by specifying one or more ports to be on that VLAN, and automatically ensure that traffic passes between the selected ports. There must not be any restriction on port location.

3. DLN Network Security

a. The system shall support the ability to enable port security, per port, per switch or per system.

b. The system shall support port security (MAC filtering) including for port connected to a daisy-chain of IP devices.

4. Network Hardware

a. Supports creation of single virtual switches consisting up to 1028 ports.

b. Supports both Ethernet and Power over Ethernet (PoE)

c. Supports fiberoptic backbone(s) with Single-strand, Single-mode Optical Fiber OS1/OS2 9/125 µm, with a reach of up to 12.5 miles

d. BACnet protocol specific network traffic

5. Redundancy

a. The system shall support the following for network redundancy:

1) Aggregation Switches

2) Spanning Tree Protocol

3) Fiber Path Redundancy

B. Subnetworks

1. Provide subnetworks for direct digital controllers and BACnet enabled field devices subordinate to Equipment Controllers (ECs) and Terminal Controllers. These subordinate devices typically include equipment such as boilers, chillers, variable frequency drive, flow meters and BTU meters. Sub-networks shall that operate on the following protocol using the specified physical layers:

   a. Subnetworks shall employ the BACnet protocol for communication between controllers. BACnet protocol implementation shall adhere to the ANSI/ASHRAE Standard 135. Communications between BACnet devices shall be 76.8 kbps over approved twisted shielded pair cabling utilizing Master/Slave Token Passing BACnet protocol. BACnet defines a comprehensive set of object types and application services for communication requirements among all levels of control in a distributed, hierarchical Building Automation System. BACnet is intended to provide a single, uniform standard for the EMCS to provide the required interoperability.

2. Strict adherence to industry standards including ANSI/ASHRAE Standard 135, BACnet, certified by BACnet Testing Laboratory (BTL listed) to assure interoperability between all system components. Controllers that are not BTL listed are unacceptable.

PART 2 - PRODUCTS

2.1 Manufacturers

A. Optigo Networks

B. Approved Equals

2.2 Operations Switch/Small Facility Aggregation Switch

A. Basis of Design: Optigo Networks ONS-CD0840GP

1. Hardware

   a. Port Configuration:

      1) (8) RJ45, 10M/100M/1G configurable with PoE+

      2) (4) SFP Uplink, 100M/1G configurable

      3) (1) Digital Input

      4) (1) Digital Output

      5) (1) RJ45 Console Port

   b. Performance:

      1) 17,856 Mpps Forwarding Capacity

      2) 24 Gbps Switching Capacity

   c. Environmental Range:

      1) Operating Temperature: -40 to 167 degrees F

      2) Operating Humidity: 5% to 95% non-condensing

   d. Mounting Configuration:

      1) DIN rail

   e. Operating Power:

1) 48 to 54 VDC
2) Max 30W output

2. Software:
   a. Ring Management:
      1) ITU-T G.8031 Ethernet Linear Protection Switching
      2) ITU-T G.8032 Ethernet Ring Protection Switching
      3) Rapid Ring w/ Self Recover Time < 20ms
   b. Device Management System (DMS):
      1) Graphical Monitoring with:
         a) Topology View
         b) Floor View
         c) Map View
      2) Search and Switch Management Functions
      3) Traffic Monitoring with Visual Chart Display
      4) Troubleshooting Tools
         a) Network diagnostics
         b) Protection Mechanisms (ex. Rate-limiting)
         c) Performance Management and Link Management
   c. Ethernet OAM
   d. Layer 2 Switching with Spanning Tree Protocol and VLAN
   e. Layer 3 Switching with IPv4 and IPv6 Static Routing

2.3 Network Controller

A. Basis of Design: Optigo Networks NC-600
   1. Hardware:
      a. Ports:
         1) (1) 10/100/1000 Mbps Management Port
         2) (5) 10/100/1000 Mbps Ethernet Ports
         3) (1) RJ45 Console Port
         4) (2) USB 2.0 Ports
      b. Power:
         1) 100-240 VAC @ 50-60 Hz
         2) Max 150W Power Supply
      c. Cooling Fan with fan speed control
      d. LCD with keypad
      e. Internal Real-Time Clock with Lithium Battery
      f. Environmental Range:
         1) Operating Temperature: -4 to 104 degrees F

2) Operating Humidity: 5% to 95% non-condensing

g. Mounting Configuration: Rack-Mounted

2. Software:

a. Optigo Oneview Network Management Software

b. Switch Management for up to 256 devices

c. Software update via USB or WebGUI

d. Web Server with HTTP/HTTPS access

e. Optigo ONS-SW-100P software license to manage up to 100 switch ports (non-expiring)

2.4 Communications Wiring

A. Category 5E Data Communication Cable:

a. Conductors

1) Solid soft drawn bare copper, ASTM B3

2) 24 AWG, 4 Pair, Twisted

b. Insulation and Jacket

1) UL listed Type CMP (Communications Multipurpose, Plenum)

2) Custom Neon Green Color

c. Standards

1) UL 444, 1666

2) TIA/EIA-568-B.2

3) ISO/IEC-11801

d. Terminations

1) RJ45

PART 3 - EXECUTION

3.1 General

A. Installation to be to manufacturer's recommendations.

B. Install equipment, wiring and raceway horizontally, vertically and parallel to walls wherever possible.

C. Provide sufficient slack and flexible connections to allow for servicing of connections.

D. Install equipment in readily accessible locations as defined by National Electrical Code (NEC) Chapter 1, Article 100, Part A.

E. Verify wiring integrity to ensure continuity and freedom from shorts and ground faults.

F. Contractor shall arrange for work inspection by authorities having jurisdiction over the work.

3.2 Communications Wiring

A. Communication wiring shall be low-voltage Class 2 wiring.

B. Install communication wiring in separate raceways and enclosures from other Class 2 wiring.

C. During installation do not exceed maximum cable pulling, tension, or bend radius specified by the cable manufacturer.

D. Verify entire network's integrity following cable installation using appropriate tests for each cable.

E. Install lightning arrestor according to manufacturer's recommendations between cable and ground where a cable enters or exits a building.

F. Each run of communication wiring shall be a continuous length without splices when that length is commercially available.

1. Runs that are longer than commercially available lengths shall have as few splices as possible using commercially available lengths.

G. Label communication wiring to indicate origination and destination.

Section 25 10 02 – Integrated Automation System Computer Systems, MMI

PART 1 - GENERAL

1.1 Related Sections

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Section 25 05 01, Integrated Automation System General Requirements

C. Section 25 05 02, Integrated Automation System Submittals

D. Section 25 05 03, Integrated Automation System Project Record Documents

E. Section 25 05 04, Integrated Automation System Start-Up, Verification and Commissioning

F. Section 25 05 05, Integrated Automation System Training

G. Section 25 10 01, Integrated Automation System Networks

H. Section 25 30 01, Integrated Automation System Field Controllers

I. Section 25 35 13, Integrated Automation System Actuators and Operators

J. Section 25 35 16, Integrated Automation System Sensors and Transmitters

K. Section 25 35 19, Integrated Automation System Control Valves

L. Section 25 35 27, Integrated Automation System Variable Frequency Drives

M. Section 25 35 30, Integrated Automation System Tubing, Cabling and Raceway

1.2 Summary

A. Owner furnished, Contractor programmed and installed server (Building Operations Server, BOS) shall be provided for centralized system control, information management, alarm management and data base management functions.

B. All real time control functions shall be resident in the standalone Building Operations Server (BOS) and local controllers (ECs and TCs).

C. Building Operations Server shall be provided complete with software as detailed within this Section.

PART 2 - PRODUCTS

2.1 Building Operations Server Hardware

A. The owner-furnished Building Operations Server shall be an APC PowerEdge R450 Server with Intel Xeon Gold 5317 3G 12 core 3.6 GHz processor with 32GB RAM and (4) 960GB SSD drives in a Raid 5 configuration. Server will be provided with a quad port OCP NIC 3.0 for device level network connections and iDRAC for remote server management.

2.2 Building Operations Server Software

A. Owner Furnished and Configured Software:

1. Windows Server 2019 64-bit operating system.

B. Contractor Furnished and Configured Software:

1. Server platform with integrated control, supervision, data logging, alarming, scheduling and network management. Platform to operate using the Niagara 4.11 framework and shall be suitable for installation in a Windows Server 2019 environment. System to be capable of streaming data and graphical displays to a standard web browser via Ethernet. Basis of Design: Distech EC-Net 4 Supervisor.

2. The software shall employ browser-like functionality for ease of navigation.
    a. It shall include a tree view (similar to Windows Explorer) for quick viewing of, and access to, the hierarchical structure of the database.
    b. In addition, menu-pull downs, and toolbars shall employ buttons, commands and navigation to permit the operator to perform tasks with a minimum knowledge of the HVAC Control System and basic computing skills.
        1) These shall include, but are not limited to, forward/backward buttons, home button, and a context sensitive locator line (similar to a URL line), that displays the location and the selected object identification.
3. Tagging:
    a. Software shall include a point and device identification system capable of supporting advanced queries of the Integrated Automation System.
4. Real-Time Displays:
    a. Provide a visual graphical representation of buildings, floor layouts, each piece of mechanical equipment and/or mechanical system that duplicates the represented system, presented as a web page via any industry standard web browser, where applicable.
    b. Graphics shall include at a minimum the value of each input, each output, each setpoint, alarms and graphical representation of trend logs.
    c. The graphic shall provide for the ability to command each point, including both timed and permanent overrides.
    d. Provide for all information represented in the graphics in an associated graphical table with links to the equipment graphics and command-able points.
5. The Operator software, shall at a minimum, support the following graphical features and functions:
    a. Graphic screens shall be developed using GIF, PNG, JPG or ICO file format. Use of proprietary graphic file formats shall not be acceptable. In addition to, or in lieu of a graphic background, the GUI shall support the use of scanned pictures.
    b. Graphic screens shall have the capability to contain objects for text, real-time values, animation, color spectrum objects, logs, graphs, HTML or XML document links, schedule objects, hyperlinks to other URLs, and links to other graphic screens.
    c. Graphics shall support layering and each graphic object shall be configurable for assignment to one a layer. A minimum of six layers shall be supported.
6. Modifying common application objects, such as schedules, calendars, and set points shall be accomplished in a graphical manner.
    a. Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
    b. Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.
7. Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.
8. Right-clicking the selected object and using a graphical slider to adjust the value shall make adjustments to analog objects, such as set points. No entry of text shall be required.
9. System Configuration:
    a. At a minimum, the Operator software shall permit the operator to perform the following tasks, with proper password access:

1) Create, delete or modify control strategies.
2) Add/delete objects to the system.
3) Tune control loops through the adjustment of control loop parameters.
4) Enable or disable control strategies.
5) Select points to be alarm-able and define the alarm state.
6) Select points to be trended over a period of time and initiate the recording of values automatically.

10. On-Line Help:
    a. Provide a context sensitive, on-line help system to assist the operator in operation and editing of the system.
        1) On-line help shall be available for all applications and shall provide the relevant data for that particular screen.
        2) Additional help information shall be available through the use of hypertext.
        3) All system documentation and help files shall be in HTML format.
11. Security:
    a. Each operator shall be required to log on to that system with a user name and password in order to view, edit add, or delete data.
    b. System security shall be selectable for each operator.
    c. The system administrator shall have the ability to set passwords and security levels for all other operators.
    d. Each operator password shall be able to restrict the operators' access for viewing and/or changing each system application, full screen editor, and object.
    e. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected.
    f. This auto log-off time shall be set per operator password.
    g. All system security data shall be stored in an encrypted format.
12. System Diagnostics:
    a. The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers.
    b. The failure of any device shall be annunciated to the operator.
13. Alarm Console:
    a. The system shall be provided with a dedicated alarm window or console.
        1) This window will notify the operator of an alarm condition, and allow the operator to view details of the alarm and acknowledge the alarm.
        2) The use of the Alarm Console can be enabled or disabled by the system administrator.
            a) When the Alarm Console is enabled, a separate alarm notification window will supersede all other windows on the desktop and shall not be capable of being minimized or closed by the operator.
        3) This window will notify the operator of new alarms and un-acknowledged alarms.
    b. Alarm notification windows or banners that can be minimized or closed by the operator shall not be acceptable.

14. Operator's software shall contain an easy-to-operate system; allowing configuration of system-wide controllers, including management and display of the controller programming.
    a. This system shall provide the capability to configure controller binary and analog inputs/outputs.
15. The system shall be capable of utilizing third-party Windows-based programs for such things as spreadsheet analysis, graphing, charting, custom report generation, and graphics design packages.
    a. Graphics generation shall be done using standard Windows packages.
    b. No proprietary graphics generation software shall be needed.
16. Provide software, which enables the non-programmer operator to easily perform, tasks which are likely to be part of his daily routine.
17. The operator's console shall provide facilities for manual entries and visual displays enabling an operator to enter information into the system and obtain displays and logs of system information.
    a. All requests for status, analog, graphic displays, logs, and control shall be selected from the operator's console.
    b. The operator interface shall minimize the use of typewriter style keyboard by implementing a mouse or similar pointing device and "point and click" approach to command selection.
    c. The facilities shall be provided to permit the operator to perform the following tasks:
        1) Automatic logging of digital alarms and change of status message.
        2) Automatic logging of all analog alarms.
        3) System changes (alarm limits, set-points, alarm lock-outs, etc.).
        4) Display specific points as requested by the operator.
        5) Provide reports as requested by the operator and on Scheduled basis where so required.
        6) Display graphics as requested by the operator.
        7) Display of help information.
        8) Provide trend logs as required by the operator.
        9) Provide manual control of digital and analog outputs as required by the operator.
        10) Direct the hard copy output of information to the device selected by the operator.
        11) Data displayed on monitor to cyclic update as appropriate.
18. Online changes:
    a. Alarm limits.
    b. Setpoints.
    c. Dead-bands
    d. Changes/deletions/additions of points.
    e. Control and change of state changes.
    f. Time of day, day, month, year.
    g. Control loop control description changes.
    h. Control loop tuning changes

i. Schedule changes

j. Changes/additions/deletions to system graphics

k. Changes/additions/deletions to total systems

19. It shall be possible for the operator to override automatic analog and digital output commands.

    a. Where the IAS software normally originates these outputs, the provision shall exist for the operator to terminate automatic IAS control of any particular output and to originate a manual analog or digital output command.

    b. The provision shall exist for the operator to return analog or digital output command functions to automatic IAS software control.

    c. It shall be possible for the operator to place any computed system setpoint to a computed basis as and when required.

    d. All above functions shall operate under the password protection system.

20. A vocabulary of at least 25 different descriptions using at least six alphanumeric characters to identify engineering units for analog input and output points. Typical description is as follows: %, ˚C, KPA, KW, KWH, L/S, CFM, ˚F, and PSI.

    a. The descriptions shall be alterable from the operator interface with the system on-line.

21. Upon operator's request, the system shall present the condition of any single point, any system, and area or the whole system on user interface.

    a. Analog values and status displayed on the user interface shall be updated whenever new values are received.

    b. Points in alarm shall be flagged by blinking, inverse video different color, bracketed, or by some other means to differentiate them from points not in alarm.

22. Error Messages

    a. Inform operator of all errors in data, errors in entry instructions, failure of equipment to respond to requests or commands, or failure of communications between components of EMCS.

    b. Error messages to be comprehensive and communicate clearly to operator precise nature of problem.

23. Password Protection

    a. Provide security system that prevents unauthorized use unless operator is logged on.

    b. Access shall be limited to operator's user interface functions unless user is logged on, including displays as outlined above.

    c. Provide security for 100 users minimum.

    d. Each user shall have an individual User ID, User Name and Password.

    e. Entries are alphanumeric characters only and are case sensitive (except for User ID).

    f. Each system user shall be allowed individual assignment of only those control functions and menu items to which that user requires access.

    g. All passwords, user names, and access assignments shall be adjustable online at the operator user interface.

    h. Each user shall also have a set security level, which defines access to displays and individual objects the user may control.

    i. System shall include 10 separate and distinct security levels for assignment to users.

24. Trend Data
    a. System shall periodically gather historically recorded selected samples of object data stored in the field equipment (global controllers, field controllers) and archive the information on the Building Operation Server SSD.
        1) Archived files shall be appended with new sample data, allowing samples to be accumulated over 5 years.
        2) Systems that write over archived data shall not be allowed, unless limited file size is specified.
        3) Samples may be viewed at the operator's terminal in a trend log.
        4) Logged data shall be stored in spreadsheet format.
        5) Operator shall be able to scroll through all trend log data.
        6) System shall automatically open archive files as needed to display archived data when operator scrolls through the data vertically.
        7) All trend log information shall be displayed in standard engineering units.
    b. Software shall be included that is capable of graphing the trend logged object data. Software shall be capable of creating two-axis (x,y) graphs that display up to six object types at the same time in different colors and these Graphs shall show object type value relative to time.
25. Software shall be included that is capable of graphing the trend logged object data. Software shall be capable of creating two-axis (x,y) graphs that display up to six object types at the same time in different colors and these Graphs shall show object type value relative to time.
26. Operator shall be able to change trend log setup information.
    a. This includes the information to be logged as well as the interval at which it is to be logged.
        1) Minimum interval of 1 minute.
    b. All input, output, and value object types in the system may be logged.
    c. All operations shall be password protected.
    d. Setup and viewing may be accessed directly from any and all graphics object is displayed on.
27. System shall be capable of periodically gathering energy log data stored in the field equipment and archive the information on the operator workstation's hard disk.
    a. Archive files shall be appended with the new data, allowing data to be accumulated over 5 years.
    b. Systems that write over archived data shall not be allowed unless limited file size is specified.
    c. System shall automatically open archive files as needed to display archived data when operator scrolls through the data.
    d. Display all energy log information in standard engineering units.
28. System software shall be provided that is capable of graphing the energy log data. Software shall be capable of creating two-axis (x,y) graph that show recorded data, relative to time.
    a. All data shall be stored in spreadsheet format for direct use by third-party spreadsheet or other database programs.
    b. Operation of system shall not be affected by this operation.
29. Operator shall be able to change the energy log setup information.

a. For meters to be logged, include meter pulse value, and the type of energy units being logged.

b. All meters monitored by the system may be logged.

c. All operations shall be password protected.

30. Graphics:

a. The operator's workstation shall display all data associated with the project.

b. The operator's user interface software shall accept, GIF, PNG, JPG and ICO format graphic files for display purposes.

c. Graphic files shall be created using scanned, full color photographs of system installation, AutoCAD or Visio drawing files of field installation drawings and wiring diagrams from as-built drawings.

d. Operator's workstation shall display all data using 2-D or 3-D graphic representations of all mechanical equipment.

e. Displays can be used as templates to produce other displays

31. System shall be capable of displaying graphic file, text, and dynamic object data together on each display.

a. Information shall be labelled with descriptors and shall be shown with the appropriate engineering units.

b. All information on any display shall be dynamically updated without any action by the user.

c. User interface shall allow user to change all field-resident IAS functions associated with the project, such as setpoints, weekly schedules, exception schedules, etc. from any screen no matter if that screen shows all text or a complete graphic display.

d. This shall be done without any reference to object addresses or other numeric/mnemonic indications.

32. All displays shall be generated and customized in such a manner by the local IAS integrator to fit the project as specified.

a. Canned displays shall not be acceptable.

b. Displays shall use Standard English for labelling and readout.

c. Systems requiring factory programming for graphics are specifically prohibited.

d. The installing contractor without factory dependency or assistance shall support all graphics and IAS programming locally.

33. Binary objects shall be displayed as ON/OFF/NULL or with customized text.

a. Text shall be justified left, right or center as selected by the user.

b. Allow binary objects to be displayed as individual change-of-state bitmap objects on the display screen such that they overlay the system graphic.

c. Each binary object displayed in this manner shall be assigned up to three bitmap files for display when the point is ON, OFF or in alarm.

d. For binary outputs, toggle the objects commanded status when the bitmap is selected with the system digitizer (mouse). Similarly, allow the terminal operator to toggle the object's status by selecting (with the mouse) a picture of a switch or light, for example, which then displays a different picture (such as an ON switch or lighted lamp).

e. Additionally, allow binary objects to be displayed as an animated graphic.

34. Animated graphic objects shall be displayed as a sequence of multiple bitmaps to simulate motion.
    a. For example: when a pump is in the OFF condition, display a stationary picture of the pump. When the operator selects the pump picture with the mouse, the represented objects status is toggled and the picture of the pumps impeller rotates in a time-based animation.
    b. The operator shall be able to click on an animated graphical object or switch it from the OFF position to ON, or ON to OFF.
    c. Allow operator to change bitmap file assignment and also create new and original bitmaps online.
    d. System shall be supplied with a library of standard bitmaps, which may be used unaltered or modified by the operator.
    e. Systems that do not allow customization or creation of new bitmap objects by the operator (or with third-party software) shall not be allowed.
35. Analog objects shall be displayed with operator modifiable units.
    a. Analog input objects may also be displayed as individual bitmap items on the display screen as an overlay to the system graphic.
    b. Each analog input object may be assigned to a minimum of five bitmap files, each with high/low limits for automatic selection and display of the bitmaps.
    c. As an example, a graphic representation of a thermometer would rise and fall in response to either the room temperature or its deviation from the controlling setpoint.
    d. Analog output objects, when selected with the mouse, shall be displayed as a prompted dialog (text only) box.
    e. Selection for display type shall be individual for each object.
    f. Analog object values may be changed by selecting either the increase or decrease arrow in the analog object spinner box without using the keypad.
36. Analog objects may also be assigned to an area of a system graphic, where the color of the defined area would change based on the analog objects value.
    a. For example, an area of a floor-plan graphic served by a single control zone would change color with respect to the temperature of the zone or its deviation from setpoint.
    b. All editing and area assignment shall be created or modified online using simple icon tools.
37. A customized menu label (push-button) shall be used for display selection.
    a. Menu items on a display shall allow penetration to lower-level displays or additional menus.
    b. Dynamic point information and menu label push buttons may be mixed on the same display to allow sub-displays to exist for each item.
    c. Each display may be protected from viewing unless operator has appropriate security level.
    d. A separate security level may be assigned to each display and system object.
38. A mouse, or other form of digitizer, shall be used to move the pointer arrow to the desired item for selection of new display or to allow the operator to make changes to object data.
39. Separate Displays shall be supplied, specific to the project, to form the following overall presentation style.
    a. The presentation will contain, at a minimum, displays for:

1) Specific Building(s)
2) Floor plates within Building(s)
3) Each controlled Zone
4) Each controlled System or Sub-System
5) Other specific displays as required by the project as shown within project drawings.

40. All Displays will be linked in a logical fashion using hyperlink style (single left mouse click on text/display object/dynamic to load linked display if programmed)
    a. Connecting to the Building IAS displays the specific building display.
    b. Clicking on a floor, displays the floor plate display
    c. Clicking on a zone, displays the specific control system for that zone.
    d. Clicking on a specific system or sub-system coarse representation at the floor plate display level displays a detailed presentation of the system or sub-system.
41. Displays are stored on the Building Operations Server and may be modified on site or via remote communications.
42. Entire system shall operate without dependency on external connections, including enterprise level servers.
43. Alarms:
    a. Operator's terminal shall provide audible, visual and electronic means of alarm indication.
    b. Any alarm may be handled based on its individual or assigned class actions.
        1) Actions are, but not limited to:
            a) Display on the Alarm console.
                i. The system shall be provided with a dedicated alarm window or console.
                ii. This window will notify the operator of an alarm condition, and allow the operator to view details of the alarm and acknowledge the alarm.
                iii. The use of the Alarm Console can be enabled or disabled by the system administrator.
                iv. When the Alarm Console is enabled, a separate alarm notification window will supersede all other windows on the desktop and shall not be capable of being minimized or closed by the operator.
                v. This window will notify the operator of new alarms and un-acknowledged alarms.
                vi. Alarm notification windows or banners that can be minimized or closed by the operator shall not be acceptable.
            b) Delivery by electronic mail (e-mail).
                i. Sent via e-mail to one or more recipients.
    c. System shall provide log of alarm messages. Alarm log shall be archived to the hard disk of the Building Operations Server.
        1) Each entry shall include a description of the event-initiating object generating the alarm, time and date of alarm occurrence, time and date of object state return to normal, and time and date of alarm acknowledgement.
    d. Alarm messages shall be in user-definable text English or other specified language) and shall be entered either at the operator's terminal or via remote communication.

44. Scheduling:
    a. Operator's terminal display of weekly schedules shall show all information in easy-to-read 7-day (weekly) format for each schedule.
        1) This includes all ON/OFF times (to the minute) for each day's events.
    b. Exception schedules (non-normal schedules, such as holidays or special events) shall display all dates that are an exception to the weekly schedules.
        1) These specialty schedules shall be displayed at the operator's terminal in a format similar to the weekly schedules, again allowing easy data entry.
        2) Exception schedule data is entered by the following methods:
            a) Date entries (one day entries)
            b) Date-to-Date (a range or span of days)
            c) By weekday (for example, a given day of a given week each month)
        3) User shall be able to scroll easily through the months for each year as a minimum.
    c. At the operator's terminal, the system user shall be able to change all information for a given weekly or exception schedule if logged on with the appropriate security access.
45. Archiving:
    a. Provide back-up copies of all controller databases to Owner for off-site storage.
    b. Provide continuous supervision of integrity of all controller databases.
        1) Data base back up and downloading to occur without operator intervention.
    c. Operator to be able to manually download entire controller database or parts thereof.
46. Reports:
    a. Provide a report facility to generate and format for display, printing, or permanent storage, as selected by the operator, the reports as specified in this section.
        1) Output to be sorted by area, system point.
    b. Periodic/Automatic Report:
        1) Provide the software to automatically generate any report specified; the user will be able to specify the type of report, start time and date, interval between reports (hourly, daily, weekly, monthly) and output device.
        2) The software will allow the operator to modify the periodic/automatic reporting profile at any time.
47. As a minimum, the following reports shall be configured on the system:
    a. Dynamic Reports: To allow operator to request a display of the dynamic value for the user specified points which shall indicate the status at the time the request was entered and updated at an operator modifiable scan frequency and it shall be possible to select points on the following basis:
        1) All points in all areas
        2) Area (all points in area)
        3) Area system (all points in system)
        4) Area system point (individual point)
        5) System (all points by system and point type)
        6) System point (all points by system and point type)

7) Area point (all points by area and point type).

48. Summary Report:
    a. To permit the display or printing of the dynamic values for the user specified points.
        1) Reports to be available on same basis as dynamic reports.
    b. Output will be to the user selected output device.
49. Trend Reports:
    a. To permit the trending of points selected by the operator, including as a minimum digital input and output, analog input and output, set points, and calculated values.
50. Historical Data Collection:
    a. Provision shall be made to ensure historical data is not lost.
        1) The ability to off-load historical data to removable media, and to later load data previously backed-up, will be provided.
        2) Historical data values, for an operator specified time range and for operator specified points, may be output the same as for trend data.
51. Critical Alarm Summary:
    a. Provide a summary of those points in the critical alarm state and include as a minimum; point acronym, point description, alarm type, limit exceed, current value, alarm type, time and date of occurrence.
52. Maintenance Alarm Summary:
    a. Provide a summary of those points in maintenance alarm and include as a minimum; point acronym, point description, current value, alarm type, limit exceed, time and date of occurrence.
53. Alarm Summary:
    a. Provide a summary of all points in alarm and include as a minimum; point acronym, point description, current value, alarm type, limit exceeded, and time and date of occurrence.
54. Disable Point Summary:
    a. Provide a summary of all points in the disabled state and include as a minimum point acronym and point description.
55. Run Time Summary:
    a. Provide a summary of the accumulated running time of selected pieces of equipment with point acronym and description, run time to date, alarm limit setting. The run time shall continue to accumulate until reset individually by means of suitable operator selection.
56. Schedule Summary:
    a. Provide a summary of all schedules and indicate as a minimum, which days are holidays and, for each section, the day of the week, the schedule times and associated values; for digital schedules value will be on or off; for analog schedules value will be an analog value.
57. User Record Summary:
    a. Provide a summary of all user records to include as a minimum; user name, password, initials, command access level and point groups assigned.

2.3 Equipment Controller (EC)/Terminal Controller (TC) Software

A. Software basis of design: Distech EC-gfxProgram.

B. The Programming software must be able to be seamlessly launched from within the Niagara Framework as a wizard.

   1. Connection methods (Tunneling or by building controller – not direct to controller).

C. Provide programming software for the Equipment Controllers (EC) and Terminal Controllers (TC) that allows for the development of control logic and point management and Graphical User Interface screens.

   1. A library of control, application, and graphic objects shall be provided to enable the creation of all applications and user interface screens.
   2. Access to these functions shall be provided through Graphical User Interface software (GUI).
   3. Applications are to be created by selecting the desired control objects from the library, dragging or pasting them on the screen, and linking them together using a built in graphical connection tool.
   4. Completed applications may be stored in the library for future use.
   5. Graphical User Interface screens shall be created in the same fashion.
   6. Data for the user displays is obtained by graphically linking the user display objects to the application objects to provide "real-time" data updates.
   7. Any real-time data value or object property may be connected to display its current value on a user display.
   8. Systems requiring separate software tools or processes to create applications and user interface displays shall not be acceptable.
   9. Programming Methods:
      a. Provide the capability to copy objects from the supplied libraries, or from a user-defined library to the user's application.
      b. Objects shall be linked by a graphical linking scheme by dragging a link from one object to another.
   10. Object links will support one-to-one, many-to-one, or one-to-many relationships.
   11. Linked objects shall maintain their connections to other objects regardless of where they are positioned on the page and shall show link identification for links to objects on other pages for easy identification.

D. Object Configuration:

   1. Each object will be done through the object's property sheet using fill-in the blank fields, list boxes, and selection buttons.
   2. Use of custom programming, scripting language, or a manufacturer-specific procedural language for configuration will not be accepted.

E. The software shall provide the ability to view the logic with values being inputted to and outputted from the graphical blocks in real time. (debug mode)

F. The system shall support object duplication within a client's database.

   1. An application, once configured, can be copied and pasted for easy re-use and duplication.
   2. All links, other than to the hardware, shall be maintained during duplication.

G. Provides function to compare and calculate from multiple values from networked controllers (BOS, EC and/or TC).

H. As a minimum, the function shall calculate and compared the values and return the average, sum, highest, lowest, 3 highest, 3 lowest values and multi-state value count.

I. System shall support auto-linking of objects to graphics.

J. System shall allow for uploading/downloading to/from multiple controllers simultaneously.

2.4 Utility Software

A. Software products shall be provided to allow the owner to access and manipulate the control schematic diagrams and to access product data sheets in an electronic format.

PART 3 - EXECUTION (Not Used)

Section 25 30 01 – Integrated Automation System Field Controllers

PART 1 - GENERAL

1.1 Related Sections

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Section 25 05 01, Integrated Automation System General Requirements

C. Section 25 05 02, Integrated Automation System Submittals

D. Section 25 05 03, Integrated Automation System Project Record Documents

E. Section 25 05 04, Integrated Automation System Start-Up, Verification and Commissioning

F. Section 25 05 05, Integrated Automation System Training

G. Section 25 10 01, Integrated Automation System Networks

H. Section 25 10 02, Integrated Automation System Computer Systems, MMI

I. Section 25 35 13, Integrated Automation System Actuators and Operators

J. Section 25 35 16, Integrated Automation System Sensors and Transmitters

K. Section 25 35 19, Integrated Automation System Control Valves

L. Section 25 35 27, Integrated Automation System Variable Frequency Drives

M. Section 25 35 30, Integrated Automation System Tubing, Cabling and Raceway

PART 2 - PRODUCTS

2.1 General

A. All controllers shall meet the following minimum requirements:

1. IP Communication (BACnet/IP)

a. BACnet/IP communication protocol shall be used for all controllers (including terminal devices such as VAVs, FCUs, etc.)

b. Support for IPv4 addressing

c. DHCP support and Auto DNS

d. Baud rate of not less than 100 Mbps

e. 2 - RJ45 ports each capable of supporting 10/100 Base-T.

1) Support of controller daisy chaining on the Ethernet network via integral switch functionality.

2) Integrated fail-safe should allow for communication when the controller is powered down.

f. All controllers shall be able to communicate peer-to-peer without the need for a Network Control Unit (such as JACE, NAE, etc.) and shall be capable of assuming all responsibilities typically assumed by a Network Control Unit.

1) Any controller on the Ethernet Data Link/Physical layer shall be able to act as a Master to allow for the exchange and sharing of data variables and messages with any other controller connected on the same communication cabling. Slave controllers are not acceptable.

2) The resulting network will be a 'Flat' topology with all devices (controllers, workstations, …) connecting at the same physical network level.

B. Control Panels:

1. Indoor control cabinets located in offices or dry/dust free environments shall be fully enclosed NEMA 1 Type construction with hinged door, and removable sub-panels or electrical sub-assemblies.
2. All outdoor control cabinets and control cabinets shall be NEMA 3R construction. All control panels located in mechanical/electrical rooms shall be NEMA 12 construction.
3. Control panels containing more than 4 controllers shall be provided with a terminal strip for field wiring. All control wiring inside the panel shall be between a terminal strip and controller inputs/outputs. All field control wiring shall be terminated at the terminal strip. Field control wiring inputs/outputs shall never be run directly to inputs/outputs of controller.

2.2 Equipment Controllers

A. Equipment Controller (Large)

1. Typical Applications:
   a. Central Station Air Handling Units
   b. Chilled Water Systems
   c. Heating Water Systems
2. Basis of Design: Distech ECY-S1000
3. Characteristics:
   a. Controller with remotely accessible embedded graphics, alarms, trend log, scheduling support and email notification capabilities.
   b. Expandable with capability to support up to 20 input/output modules (320 I/O) and support for BACnet MS/TP, Modbus RTU and Modbus TCP.
   c. Ethernet Communication enabled, 10/100 Mbps, Cat 5e, IPv4 addressing. (2) switched RJ-45 ports.
   d. BTL, B-BC BACnet listed with version 4.4.93 or later.
   e. Web Server Enabled with HTML5 Server Protocol and Restful API Application Interface.
   f. Processor with performance greater than or equal to Sitara ARM, 1GHz CPU speed.
   g. Minimum 4GB Non-volatile Flash memory for applications and storage with minimum 512MB RAM.
   h. Real Time Clock with rechargeable battery and SNTP network time synchronization support.
   i. Real Time Clock battery with 20-hour charge cycle and 20-day discharge time.
   j. (2) USB 2.0 Ports.
   k. (1) Micro-USB 2.0 Port.
   l. 24VAC/DC power supply.
   m. 32 to 122F operating temperature, 0% to 90% RH operating humidity, MTTF 10+ years.
4. Expansion Modules:
   a. Communications Module:
      1) Communication module shall be capable of RS-485 communication with the following requirements, without the additional gateways/routers to enable RS-485 communication.
      2) Module shall include two separate RS-485 communication ports.
      3) Allow for either Modbus RTU or BACnet MS/TP communication on either of the ports

4) Allow for a minimum of 32 Modbus RTU communicating devices and/or a minimum of 50 BACnet MS/TP communicating devices to be connected on each RS-485 segment.

b. I/O Expansion Module:

1) Each I/O expansion module shall be capable of monitoring of the following types of inputs, without the addition of equipment outside the DDC Controller cabinet:

a) Digital inputs from dry contact closure, pulse accumulators, voltage sensing.

b) Analog inputs of 4-20 mA, 0-10 Vdc, thermistor and RTD in the range 0 to 350,000 ohm.

i. The analog or universal input shall use a 16 bit A/D converter.

i) Controllers with less than 16 bit A/D converters must provide all analog input sensors with 4-20ma transmitters.

2) Each I/O expansion module shall be capable of providing the following control outputs without the addition of equipment outside the DDC controller cabinet:

a) Digital outputs including Form C relay outputs and Triac outputs

b) Analog outputs of 4-20 mA and 0-10 Vdc.

i. The analog or universal output shall use a 10 bit D/A converter.

c) Outputs shall be provided with HOA (Hand, Off, Auto) support.

3) Each completed configuration of I/O modules shall have a minimum of 10% spare capacity for each point type for future point connection.

a) Provide all processors, power supplies and communication controllers complete so that the implementation of a point only requires the addition of the appropriate point input/output termination module and wiring.

b) As a minimum, provide one of each type of point available on the controller.

4) Provide sufficient internal memory for the specified control sequences and have at least 25% of the memory available for future use.

5) Any software required for programming shall be unlicensed and openly available

6) Power and Environmental Requirements:

a) 24 VAC with local transformer power.

b) The controllers shall also function normally under ambient conditions of -40 ˚F to 158 ˚F and 0% to 90% RH (non-condensing).

B. Equipment Controller (Medium)

1. Typical Applications:

a. Small Single Zone Air Handling Units

2. Basis of Design: Distech ECY-303

3. Characteristics:

a. Controller with remotely accessible embedded graphics, alarms, trend log, scheduling support and email notification capabilities.

b. Ethernet Communication enabled, 10/100 Mbps, Cat 5e, IPv4 addressing. (2) switched RJ-45 ports.

c. BTL, B-BC BACnet listed with version 4.4.93 or later.

d. Web Server Enabled with HTML5 Server Protocol and Restful API Application Interface.

e. Processor with performance greater than or equal to Sitara ARM, 600 MHz CPU speed.

f. Minimum 4GB Non-volatile Flash memory for applications and storage with minimum 512MB RAM.

g. Real Time Clock with rechargeable battery and SNTP network time synchronization support.

h. Real Time Clock battery with 20-hour charge cycle and 20-day discharge time.

i. (2) USB 2.0 Ports.

j. (1) Micro-USB 2.0 Port.

k. 24VAC/DC power supply.

l. -40 to 122F operating temperature, 0% to 90% RH operating humidity, MTTF 10+ years.

m. (8) Software Configurable Universal Inputs, 16-bit analog to digital converter input resolution with 18VDC, 80mA maximum power supply output and auto-reset fuse for 24VAC protection. Configurable for the following functions:

1) Dry Contact

2) Dry Contact Counter, 1Hz maximum, 500ms On/500ms Off minimum duty cycle.

3) 0 to 10 VDC, 40 kΩ input impedance.

4) 0 to 5 VDC, high input impedance.

5) 0 to 20mA, 249Ω external resistor wired in parallel.

6) Resistance/Thermistor Input, 0 to 350kΩ range. Pre-configured for the following sensor types:

a) Thermistor, 10 kΩ

b) Platinum RTD, Pt1000

c) Nickel RTD, Ni1000

n. (2) Software Configurable Universal Outputs, 10-bit digital to analog converter output resolution with built-in snubbing diode for back-EMF protection, internal short-circuit protection and auto-reset fuse for 24VAC protection. Configurable for the following functions:

1) 12VDC On/Off, Maximum 20mA at 12VDC source current.

2) PWM, 2 to 65 second range with adjustable warm up and cool down time.

3) Floating, 500 millisecond minimum pulse on/off time with adjustable drive period.

o. 0 to 10VDC, 20mA maximum at 10VDC source current, 2.5mA maximum at 1VDC sink current.

p. (4) Digital Outputs, 24VAC Triac, 0.5A continuous duty rated. Configurable for the following functions:

1) 24VAC On/Off.

2) PWM, 2 to 65 second range.

3) Floating, 500 millisecond minimum pulse on/off time with adjustable drive period.

q. (2) Digital-Universal Outputs, configurable to perform functions of either Universal Output or Digital Outputs listed above.

C. Equipment Controller (Small):

1. Typical Applications:

a. Fan Coil Units.

2. Basis of Design: Distech ECY-TU-203

3. Characteristics:

a. Controller with remotely accessible embedded graphics, alarms, trend log, scheduling support and email notification capabilities.

b. Ethernet Communication enabled, 10/100 Mbps, Cat 5e, IPv4 addressing. (2) switched RJ-45 ports.

c. BTL, B-BC BACnet listed with version 4.4.93 or later.

d. Web Server Enabled with HTML5 Server Protocol and Restful API Application Interface.

e. Processor with performance greater than or equal to Sitara ARM, 600 MHz CPU speed.

f. Minimum 4GB Non-volatile Flash memory for applications and storage with minimum 512MB RAM.

g. Real Time Clock with rechargeable battery and SNTP network time synchronization support.

h. Real Time Clock battery with 20-hour charge cycle and 20-day discharge time.

i. (2) USB 2.0 Ports.

j. (1) Micro-USB 2.0 Port.

k. Internal 24VAC power supply, 600mA max, fused short circuit protection with overload protection.

l. 41 to 122F operating temperature, 0% to 90% RH operating humidity, MTTF 10+ years.

m. (3) Software Configurable Universal Inputs. Configurable for the following functions:

1) Dry Contact

2) Dry Contact Counter, 1Hz maximum, 500ms On/500ms Off minimum duty cycle.

3) 0 to 10 VDC, 40 kΩ input impedance.

4) Thermistor Input, 10 kΩ

n. (1) Software Configurable Sensor Input. Configurable for the following functions:

1) Dry Contact

2) Dry Contact Counter, 1Hz maximum, 500ms On/500ms Off minimum duty cycle.

3) Thermistor Input, 10 kΩ

o. (2) Software Configurable Digital Inputs. Configurable for the following functions:

1) Dry Contact

2) Dry Contact Counter, 1Hz maximum, 500ms On/500ms Off minimum duty cycle.

p. (3) Unpowered Relay Outputs, 100-277VAC, 3.0A max current total for three outputs. External fuse protection required. Normally open.

q. (2) 24VAC Triac Outputs, see power supply above.

r. (2) Analog Outputs, 0 to 10VDC, 5mA maximum at 10VDC source current, 2mA maximum at 1VDC sink current.

s. (2) Digital/Analog Outputs, software configurable for Triac or Analog output as listed above.

2.3 Terminal Controllers

A. Terminal Unit Controller:

1. Basis of Design: Distech ECY-VAV (Plenum Rated)

2. Characteristics:

a. Variable air volume terminal unit controller with remotely accessible embedded graphics, alarms, trend log, scheduling support and email notification capabilities.

b. Ethernet Communication enabled, 10/100 Mbps, Cat 5e, IPv4 addressing. (2) switched RJ-45 ports.

c. BTL, B-BC BACnet listed with version 4.4.93 or later.

d. Web Server Enabled with HTML5 Server Protocol and Restful API Application Interface.

e. Minimum 4GB Non-volatile Flash memory for applications and storage with minimum 512MB RAM.

f. Real Time Clock with rechargeable battery and SNTP network time synchronization support.

g. Real Time Clock battery with 20-hour charge cycle and 20-day discharge time.

h. (2) USB 2.0 Ports.

i. (1) Micro-USB 2.0 Port.

j. Internal 24VAC power supply, 7VA nominal power consumption with 20VA full load/peak power consumption and field replaceable fused overcurrent protection.

k. 32 to 122F operating temperature, 0% to 90% RH operating humidity, MTTF 10+ years.

l. On-Board Air-Flow Sensor

    1) +/- 2.0 in. W.C. sensing range, polarity-free high-low sensor connection.

    2) 0.00007 in. W.C. input resolution.

    3) +/- 1.5% airflow accuracy @ >0.05 in. W.C. differential pressure after calibration.

m. (4) Software Configurable Universal Inputs, 16-bit analog to digital converter input resolution with 18VDC, 80mA maximum power supply output and auto-reset fuse for 24VAC protection. Configurable for the following functions:

    1) Dry Contact

    2) Dry Contact Counter, 1Hz maximum, 500ms On/500ms Off minimum duty cycle.

    3) 0 to 10 VDC, 40 kΩ input impedance.

    4) 0 to 5 VDC, high input impedance.

    5) 0 to 20mA, 249Ω external resistor wired in parallel.

    6) Resistance/Thermistor Input, 0 to 350kΩ range. Pre-configured for the following sensor types:

    7) Thermistor, 10 kΩ

    8) Platinum RTD, Pt1000

    9) Nickel RTD, Ni1000

n. (2) Software Configurable Universal Outputs, 10-bit digital to analog converter output resolution with built-in snubbing diode for back-EMF protection, internal short-circuit protection and auto-reset fuse for 24VAC protection. Configurable for the following functions:

    1) 12VDC On/Off, Maximum 20mA at 12VDC source current.

    2) PWM, 2 to 65 second range with adjustable warm up and cool down time.

    3) Floating, 500 millisecond minimum pulse on/off time with adjustable drive period.

    4) 0 to 10VDC, 20mA maximum at 10VDC source current, 2.5mA maximum at 1VDC sink current.

o. (4) Digital Outputs, 24VAC Triac, 0.5A continuous duty rated. Configurable for the following functions:

    1) 24VAC On/Off.

2) PWM, 2 to 65 second range.

3) Floating, 500 millisecond minimum pulse on/off time with adjustable drive period.

2.4 Sensors

A. Wall Mount Sensors:

1. Basis of Design:

a. Distech Allure EC-Smart-Vue Series

1) EC-Smart-Vue for Temperature Only

2) EC-Smart-Vue-H for Temperature/Humidity

3) EC-Smart-Vue-C for Temperature/Carbon Dioxide

4) EC-Smart-Vue-CH for Temperature/Humidity/Carbon Dioxide

2. Characteristics:

a. Operator Interface: Icon-based with interactive backlit LCD display.

1) Display suitable for use as HVAC equipment configuration and troubleshooting tool.

2) Display to cycle through all measured/controlled values (temperature, humidity and carbon dioxide ppm as applicable).

3) Interface to allow for adjustment of space temperature setpoint.

b. White ABS housing, UL94-V1. Wall surface mount through mounting holes

c. Communications/Power:

1) T568B Cat 5e network cable w/ RJ-45 connector.

2) Device to be provided with input and output connector to allow for pass-through for daisy chain connection of up to 12 total room devices.

d. Temperature Sensor:

1) 10 kOhm NTC Thermistor

2) 41 to 104F range at +/- 0.5F accuracy and 0.18F resolution.

e. Humidity Sensor: +/- 3% accuracy, 1% resolution.

f. Carbon Dioxide Sensor:

1) 0 to 2000 ppm measurement range.

2) Accuracy equal to the greater of +/- 30 ppm or 3% of reading within ranges of 400-1250 ppm carbon dioxide concentration.

3) Stability: Drifty of less than 2% of full scale over 15 year life of sensor.

4) Sensing method: non-dispersive infrared absorption.

B. Ceiling Mount Sensors:

1. Basis of Design:

a. Distech Allure EC-Multi-Sensor-BLE

2. Characteristics:

a. White ABS housing, UL94-V1. Ceiling surface mount.

b. Communications/Power:

1) 16VDC Maximum

2) Power and Communications through T568B Cat 5e network cable w/ RJ-45 connector.

c. Wireless Communication:
   1) Bluetooth v4.2.
d. Temperature Sensor:
   1) 10 kOhm NTC Thermistor
   2) 41 to 104F range at +/- 0.5F accuracy and 0.18F resolution.
e. Luminosity Sensor: Photodiode, 0-4000 lux.
f. Motion Sensor:
   1) 16-face Fresnel lens optics.
   2) Quad type passive infrared motion sensor element w/ 16' rated detection distance.

PART 3 - EXECUTION

3.1 Manufacturer's Recommendations

A. Installation to be to manufacturer's recommendations. Provide printed copies of recommendations with shop drawings or product data.

3.2 General Workmanship

A. Install equipment, piping, and wiring or raceway horizontally, vertically, and parallel to walls wherever possible.
B. Provide sufficient slack and flexible connections to allow for piping and equipment vibration isolation.
C. Install equipment in readily accessible locations as defined by National Electrical Code (NEC) Chapter 1 Article 100 Part A.
D. Verify wiring integrity to ensure continuity and freedom from shorts and ground faults.
E. Equipment, installation, and wiring shall comply with industry specifications and standards and local codes for performance, reliability, and compatibility.

3.3 Wiring

A. Control and interlock wiring and installation shall comply with national and local electrical codes, Division 26, and manufacturer's recommendations. Where the requirements of this Section differ from other Divisions, this Section shall take precedence.
B. NEC Class 1 (line voltage) wiring shall be UL listed in approved raceway as specified by NEC.
C. Low-voltage wiring shall meet NEC Class 2 requirements. Sub-fuse low-voltage power circuits as required to meet Class 2 current limit.
D. NEC Class 2 (current-limited) wires not in raceway but in concealed and accessible locations such as return air plenums shall be UL listed for the intended application.
E. Install wiring in raceway where subject to mechanical damage, where exposed in occupied spaces and in mechanical, electrical, or service rooms.
F. Install Class 1 and Class 2 wiring in separate raceways. Boxes and panels containing high-voltage wiring and equipment shall not be used for low-voltage wiring except for the purpose of interfacing the two through relays and transformers.
G. Do not install wiring in raceway containing tubing.
H. Run exposed Class 2 wiring parallel to a surface or perpendicular to it and tie neatly at 10 ft. intervals
I. Use structural members to support or anchor plenum cables without raceway. Do not use ductwork, electrical raceways, piping, or ceiling suspension systems to support or anchor cables.

J. Secure raceways with raceway clamps fastened to structure and spaced according to code requirements. Raceways and pull boxes shall not be hung on or attached to ductwork, electrical raceways, piping, or ceiling suspension systems.

K. Size raceway and select wire size and type in accordance with manufacturer's recommendations and NEC requirements.

L. Include one pull string in each raceway 1 in. or larger.

M. Use color-coded conductors throughout.

N. Locate control and status relays in designated enclosures only. Do not install control and status relays in packaged equipment control panel enclosures containing Class 1 starters.

O. Conceal raceways except within mechanical, electrical, or service rooms. Maintain minimum clearance of 6 in. between raceway and high-temperature equipment such as steam pipes or flues.

P. Adhere to requirements in Division 26 where raceway crosses building expansion joints.

Q. Install insulated bushings on raceway ends and enclosure openings. Seal top ends of vertical raceways.

R. Terminate control and interlock wiring related to the work of this section. Maintain at the job site updated (as-built) wiring diagrams that identify terminations.

S. Flexible metal raceways and liquid-tight flexible metal raceways shall not exceed 1 m (3 ft) in length and shall be supported at each end. Do not use flexible metal raceway less than ½ in. electrical trade size. Use liquid-tight flexible metal raceways in areas exposed to moisture including chiller and boiler rooms.

T. Install raceway rigidly, support adequately, ream at both ends, and leave clean and free of obstructions. Join raceway sections with couplings and according to code. Make terminations in boxes with fittings. Make terminations not in boxes with bushings.

3.4 Communications Wiring

A. Communication wiring shall be low-voltage Class 2 wiring and shall comply with Article 3.7 (Wiring).

B. Install communication wiring in separate raceways and enclosures from other Class 2 wiring.

C. During installation do not exceed maximum cable pulling, tension, or bend radius specified by the cable manufacturer.

D. Verify entire network's integrity following cable installation using appropriate tests for each cable.

E. Install lightning arrestor according to manufacturer's recommendations between cable and ground where a cable enters or exits a building.

F. Each run of communication wiring shall be a continuous length without splices when that length is commercially available.

G. Runs that are longer than commercially available lengths shall have as few splices as possible using commercially available lengths.

H. Label communication wiring to indicate origination and destination.

Section 25 35 13 – Integrated Automation System Actuators and Operators

PART 1 - GENERAL

1.1 Related Sections

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Section 25 05 01, Integrated Automation System General Requirements

C. Section 25 05 02, Integrated Automation System Submittals

D. Section 25 05 03, Integrated Automation System Project Record Documents

E. Section 25 05 04, Integrated Automation System Start-Up, Verification and Commissioning

F. Section 25 05 05, Integrated Automation System Training

G. Section 25 10 01, Integrated Automation System Networks

H. Section 25 10 02, Integrated Automation System Computer Systems, MMI

I. Section 25 30 01, Integrated Automation System Field Controllers

J. Section 25 35 16, Integrated Automation System Sensors and Transmitters

K. Section 25 35 19, Integrated Automation System Control Valves

L. Section 25 35 27, Integrated Automation System Variable Frequency Drives

M. Section 25 35 30, Integrated Automation System Tubing, Cabling and Raceway

PART 2 - PRODUCTS

2.1 Relays

A. General-Purpose Relays:

1. Relays shall be heavy duty and rated for at least 10 A at 250-V ac and 60 Hz.
2. Relays shall be either double pole double throw (DPDT) or three-pole double throw, depending on the control application.
3. Use a plug-in-style relay with an eight-pin octal plug for DPDT relays and an 11-pin octal plug for three-pole double-throw relays.
4. Construct the contacts of either silver cadmium oxide or gold.
5. Enclose the relay in a clear transparent polycarbonate dust-tight cover.
6. Relays shall have LED indication and a manual reset and push-to-test button.
7. Performance:
   a. Mechanical Life: At least 10 million cycles.
   b. Electrical Life: At least 100,000 cycles at rated load.
   c. Pickup Time: 15 ms or less.
   d. Dropout Time: 10 ms or less.
   e. Pull-in Voltage: 85 percent of rated voltage.
   f. Dropout Voltage: 50 percent of nominal rated voltage.
   g. Power Consumption: 2 VA.

h. Ambient Operating Temperatures: Minus 40 to 115 deg F.

8. Equip relays with coil transient suppression to limit transients to non-damaging levels.
9. Plug each relay into an industry-standard, 35-mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
10. Relay socket shall have screw terminals. Mold into the socket the coincident screw terminal numbers and associated octal pin numbers.

B. Multifunction Time-Delay Relays:

1. Relays shall be continuous duty and rated for at least 10 A at 240-V ac and 60 Hz.
2. Relays shall be DPDT relay with up to eight programmable functions to provide on/off delay, interval and recycle timing functions.
3. Use a plug-in-style relay with either an 8- or 11-pin octal plug.
4. Construct the contacts of either silver cadmium oxide or gold.
5. Enclose the relay in a dust-tight cover.
6. Include knob and dial scale for setting delay time.
7. Performance:
   a. Mechanical Life: At least 10 million cycles.
   b. Electrical Life: At least 100,000 cycles at rated load.
   c. Timing Ranges: Multiple ranges from 0.1 seconds to 100 minutes.
   d. Repeatability: Within 2 percent.
   e. Recycle Time: 45 ms.
   f. Minimum Pulse Width Control: 50 ms.
   g. Power Consumption: 5 VA or less at 120-V ac.
   h. Ambient Operating Temperatures: Minus 40 to 115 deg F.
8. Equip relays with coil transient suppression to limit transients to non-damaging levels.
9. Plug each relay into an industry-standard, 35-mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
10. Relay socket shall have screw terminals. Mold into the socket the coincident screw terminal numbers and associated octal pin numbers.

C. Latching Relays:

1. Relays shall be continuous duty and rated for at least 10 A at 250-V ac and 60 Hz.
2. Relays shall be either DPDT or three-pole double throw, depending on the control application.
3. Use a plug-in-style relay with a multibladed plug.
4. Construct the contacts of either silver cadmium oxide or gold.
5. Enclose the relay in a clear transparent polycarbonate dust-tight cover.
6. Performance:
   a. Mechanical Life: At least 10 million cycles.
   b. Electrical Life: At least 100,000 cycles at rated load.
   c. Pickup Time: 15 ms or less.
   d. Dropout Time: 10 ms or less.

e. Pull-in Voltage: 85 percent of rated voltage.

f. Dropout Voltage: 50 percent of nominal rated voltage.

g. Power Consumption: 2 VA.

h. Ambient Operating Temperatures: Minus 40 to 115 deg F.

7. Equip relays with coil transient suppression to limit transients to non-damaging levels.

8. Plug each relay into an industry-standard, 35-mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.

9. Relay socket shall have screw terminals. Mold into the socket the coincident screw terminal numbers and associated octal pin numbers.

D. Current Sensing Relay:

1. Monitors ac current.

2. Independent adjustable controls for pickup and dropout current.

3. Energized when supply voltage is present and current is above pickup setting.

4. De-energizes when monitored current is below dropout current.

5. Dropout current is adjustable from 50 to 95 percent of pickup current.

6. Include a current transformer, if required for application.

7. House current sensing relay and current transformer in its own enclosure. Use

8. NEMA 250, Type 12 enclosure for indoors and NEMA 250, Type 4 for outdoors.

E. Combination On-Off Status Sensor and On-Off Relay:

1. Description:

a. On-off control and status indication in a single device.

b. LED status indication of activated relay and current trigger.

c. Closed-Open-Auto override switch located on the load side of the relay.

2. Performance:

a. Ambient Temperature: Minus 30 to 140 deg F.

b. Voltage Rating: Single-phase loads rated for 300-V ac. Three-phase loads rated for 600-V ac.

3. Status Indication:

a. Current Sensor: Integral sensing for single-phase loads up to 20 A and external solid or split sensing ring for three-phase loads up to 150 A.

b. Current Sensor Range: As required by application.

c. Current Set Point: Fixed or adjustable as required by application.

d. Current Sensor Output:

1) Solid-state, single-pole double-throw contact rated for 30-V ac and dc and for 0.4A.

2) Solid-state, single-pole double-throw contact rated for 120-V ac and 1.0A.

3) Analog, zero- to 5- or 10-V dc.

4) Analog, 4 to 20 mA, loop powered.

4. Relay: Single-pole double-throw, continuous-duty coil; rated for 10-million mechanical cycles.

5. Enclosure: NEMA 250, Type 1 enclosure.

2.2 Actuators

A. Electronic Damper and Valve Actuators: Direct-coupled type nonhydraulic designed for minimum 100,000 full-stroke cycles at rated torque. The actuator shall have rating of not less than twice the thrust needed for actual operation of the damper or valve.

1. Approved Manufacturers:
    a. Belimo.
2. Coupling: V-bolt and V-shaped, toothed cradle.
3. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
4. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on non-spring-return actuators.
5. Actuators shall have the ability to be tandem mounted.
6. All spring-return actuators shall have a manual override. Complete manual override shall take no more than 10 turns.
7. Power Requirements (Two-Position Spring Return): 24V ac or dc, Maximum 10VA.
8. Power Requirements (Modulating): Maximum 15 VA at 24V ac.
9. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
10. Temperature Rating: -22°F to 140ºF.
11. Run Time: 200 seconds open, 40 seconds closed.
12. All actuators shall have a 1-year warranty
13. Valves:
    a. Size for torque required for valve close-off at maximum pump differential pressure (regardless of water loop system pressures).
    b. Valve and Actuators shall come from the factory fully assembled.
    c. Spring Return Manual Override shall come with a 10-degree valve preload to assure tight close off.
14. Dampers:
    a. Size for running torque calculated as follows:
        1) Parallel-Blade Damper with Edge Seals: 7 inch-pounds/sq. ft. of damper.
        2) Opposed-Blade Damper with Edge Seals: 5 inch-pounds/sq. ft. of damper.
        3) Parallel-Blade Damper without Edge Seals: 4 inch-pounds/sq. ft. of damper.
        4) Opposed-Blade Damper without Edge Seals: 3 inch-pounds/sq. ft. of damper.
        5) Dampers with 2 to 3 Inches water column of Pressure Drop or Face Velocities of 1000 to 2500 FPM - multiply the minimum torque values by 1.5.
        6) Dampers with 3 to 4 Inches water column of Pressure Drop or Face Velocities of 2500 to 3000 FPM – multiply the minimum torque values above by 2.0.
15. Spring Return Manual Override actuators shall have a factory set 5 degree damper preload.

PART 3 - EXECUTION (Not Used)

Section 25 35 16 – Integrated Automation System Sensors and Transmitters

PART 1 - GENERAL

1.1 Related Sections

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Section 25 05 01, Integrated Automation System General Requirements

C. Section 25 05 02, Integrated Automation System Submittals

D. Section 25 05 03, Integrated Automation System Project Record Documents

E. Section 25 05 04, Integrated Automation System Start-Up, Verification and Commissioning

F. Section 25 05 05, Integrated Automation System Training

G. Section 25 10 01, Integrated Automation System Networks

H. Section 25 10 02, Integrated Automation System Computer Systems, MMI

I. Section 25 30 01, Integrated Automation System Field Controllers

J. Section 25 35 13, Integrated Automation System Actuators and Operators

K. Section 25 35 19, Integrated Automation System Control Valves

L. Section 25 35 27, Integrated Automation System Variable Frequency Drives

M. Section 25 35 30, Integrated Automation System Tubing, Cabling and Raceway

PART 2 - PRODUCTS

2.1 Sensors

A. Electronic Temperature Sensors: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.

1. Resistance Temperature Detectors: Platinum

   a. Accuracy: Plus or minus 0.2 percent at calibration point.

   b. Wire: Twisted, shielded-pair cable

   c. Insertion Elements in Ducts: Single point, 6 inches long; use where not affected by temperature stratification or where ducts are smaller than 4 sq. ft.

   d. Averaging Elements in Ducts: shall be flexible for use where prone to temperature stratification or where ducts are larger than 4 sq. ft.; 264 inches long, flexible for use where prone to temperature stratification or where ducts are larger than 16 sq. ft; length as required.

   e. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches.

   f. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.

   g. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

2. Humidity Sensors: Bulk polymer sensor element.

   a. Accuracy: 2 percent at 10-90% RH with linear output.

   b. Room Sensors: Range of 0 to 100 percent relative humidity

c. Duct and Outside-Air Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.

3. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.

a. Accuracy: +/- 1 percent of full scale with repeatability of 0.5 percent.

b. Output: 4 to 20 mA, 0-5 vDC, 0-10 vDC.

c. Building Static-Pressure Range: -.1 to .1, -0.25 to 0.25, -.5 to .5, -1.0 to 1.0 IN WC, jumper selectable.

d. Duct Static-Pressure Range: 0 to 1, 0 to 2.5, 0 to 5, 0 to 10 IN WC., jumper adjustable.

4. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; proportional output 4 to 20 mA.

B. Equipment Operation Sensors:

1. Status Inputs for Fans: Differential-pressure switch with adjustable range of 0 to 5 IN WC.

2. Status Inputs for Pumps: Differential-pressure switch piped across pump with adjustable pressure-differential range of 8 to 60 psig.

3. Status Inputs for Electric Motors: Current-sensing relay with current transformers, adjustable and set to 175 percent of rated motor current.

4. Electronic Valve/Damper Position Indication: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.

2.2 Thermostats

A. Electric Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic-reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below set point.

1. Bulb Length: Minimum 20 feet

2. Quantity: One thermostat for every 20 sq. ft. of coil surface.

3. Provide manual test button.

4. Provide auxiliary contacts to monitor status.

PART 3 - EXECUTION (Not Used)

Section 25 35 19 – Integrated Automation System Control Valves

PART 1 - GENERAL

1.1 Related Sections

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Section 25 05 01, Integrated Automation System General Requirements

C. Section 25 05 02, Integrated Automation System Submittals

D. Section 25 05 03, Integrated Automation System Project Record Documents

E. Section 25 05 04, Integrated Automation System Start-Up, Verification and Commissioning

F. Section 25 05 05, Integrated Automation System Training

G. Section 25 10 01, Integrated Automation System Networks

H. Section 25 10 02, Integrated Automation System Computer Systems, MMI

I. Section 25 30 01, Integrated Automation System Field Controllers

J. Section 25 35 13, Integrated Automation System Actuators and Operators

K. Section 25 35 16, Integrated Automation System Sensors and Transmitters

L. Section 25 35 27, Integrated Automation System Variable Frequency Drives

M. Section 25 35 30, Integrated Automation System Tubing, Cabling and Raceway

PART 2 - PRODUCTS

2.1 Control Valves

A. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

B. Ball Control Valves NPS 3-inch and Smaller: Belimo B2 or B3 Series, characterized, bronze body, stainless steel ball and stem, PTFE seats, two or three ports as indicated, replace plugs and seats, union and threated ends, or flanged for 2-1/2 and larger.

1. Rating: Class 125 for service at 125 psi and 250 deg F operating conditions.
2. Sizing: 3-psig maximum pressure drop at design flow rate, to close against pump shutoff head.
3. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.

C. Butterfly Valves: 200 psi rating. 150 psi maximum pressure differential, ASTM A126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless steel stem, field-replaceable EPDM or Buna N sleeve and stem seals.

1. Body Style: Wafer, Lug, or Groove.
2. Disc Type: Nickel-plated ductile iron, Aluminum bronze, Elastomer-coated ductile iron, or Epoxy-coated ductile iron.
3. Sizing: 3 psi. maximum pressure drop at design flow rate.
4. Terminal Unit Control Valves: Bronze body, stainless steel ball and stem, Teflon PTFE seats, two- or three-port as indicated, replaceable plugs and seats, union and threaded ends.
5. Rating: Class 125 for service at 125 psi. and 250ºF operating conditions.

6. Sizing: 3 psi. maximum pressure drop at design flow rate, to close against pump shutoff head.
7. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.

PART 3 - EXECUTION (Not Used)

Section 25 35 27 – Integrated Automation System Variable Frequency Drives

PART 1 - GENERAL

1.1 Related Sections

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Section 25 05 01, Integrated Automation System General Requirements

C. Section 25 05 02, Integrated Automation System Submittals

D. Section 25 05 03, Integrated Automation System Project Record Documents

E. Section 25 05 04, Integrated Automation System Start-Up, Verification and Commissioning

F. Section 25 05 05, Integrated Automation System Training

G. Section 25 10 01, Integrated Automation System Networks

H. Section 25 10 02, Integrated Automation System Computer Systems, MMI

I. Section 25 30 01, Integrated Automation System Field Controllers

J. Section 25 35 13, Integrated Automation System Actuators and Operators

K. Section 25 35 16, Integrated Automation System Sensors and Transmitters

L. Section 25 35 19, Integrated Automation System Control Valves

M. Section 25 35 30, Integrated Automation System Tubing, Cabling and Raceway

1.2 Summary

A. This Section includes solid-state, PWM, Variable Frequency Drives for speed control of three-phase, squirrel-cage induction motors.

1.3 Definitions

A. BAS: Building automation system.

B. IGBT: Integrated gate bipolar transistor.

C. LAN: Local area network.

D. PID: Control action, proportional plus integral plus derivative.

E. PWM: Pulse-width modulated.

F. VFD: Variable frequency drive.

G. NRTL: Nationally Recognized Testing Laboratory.

1.4 Quality Assurance

A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

1.5 Delivery, Storage and Handling

A. Store VFD's indoors in clean, dry space with uniform temperature to prevent condensation. Protect VFD's from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.6 Project Conditions

A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions, unless otherwise indicated:

1. Ambient Temperature: 0 to 40 deg C (5 deg to 104 deg F).
2. Humidity: Less than 95 percent (noncondensing).
3. Altitude: Not exceeding 3300 feet.

1.7 Coordination

A. Coordinate layout and installation of VFD's with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate features, accessories, and functions of each VFD and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

C. Coordinate sizing of VFD’s to match horsepower, output amps, and electrical characteristic requirements with submittal data for the equipment being provided on this project.

1.8 Warranty

A. Special Warranty: Manufacturers standard form in which manufacturer agrees to provide onsite parts and labor warranty for a period of two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 Manufacturers

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB Power Distribution, Inc.; ABB Control, Inc. Subsidiary Series ACH 580.

2.2 Variable Frequency Drives

A. Description: NEMA ICS 2, IGBT, PWM, VFD; listed and labeled as a complete unit and arranged to provide variable speed of an NEMA MG 1, Design B, 3-phase induction motor by adjusting output voltage and frequency.

1. Provide unit suitable for operation of premium-efficiency motor as defined by NEMA MG 1.
2. Unit shall be plenum rated.

B. Design and Rating: Match load type such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

C. Output Rating: 3-phase; 6 to 90 Hz, with voltage proportional to frequency throughout voltage range.

D. Unit Operating Requirements:

1. Input ac voltage tolerance of plus or minus 10 percent.
2. Input frequency tolerance of 60 Hz, plus or minus 6 percent.
3. Minimum Efficiency: 98 percent at 60 Hz, full load.
4. Minimum Displacement Primary-Side Power Factor: 98 percent.
5. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.

6. Starting Torque: 100 percent of rated torque or as indicated.
7. Speed Regulation: Plus or minus 1 percent.
8. Input Line Impedance: 5 percent.

E. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.
1. Electrical Signal: 4 to 20 mA at 24 V.

F. Internal Adjustability Capabilities:
1. Minimum Speed: 30 percent of maximum rpm.
2. Maximum Speed: 80 to 100 percent of maximum rpm.
3. Acceleration: 1 to a minimum of 1800 seconds.
4. Deceleration: 1 to a minimum of 1800 seconds.
5. Current Limit: 110 percent of maximum rating.

G. Self-Protection and Reliability Features:
1. Input transient protection by means of surge suppressors.
2. Under- and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
3. Motor Overload Relay: Adjustable and capable of NEMA ICS 2, Class 20 or 30 performance.
4. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
5. Instantaneous line-to-line and line-to-ground overcurrent trips.
6. Loss-of-phase protection.
7. Reverse-phase protection.
8. Short-circuit protection.
9. Motor overtemperature fault.
10. Fast acting drive input fuses.

H. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional auto speed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.

I. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

J. Motor Temperature Compensation at Slow Speeds: Adjustable current fallback based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

K. Input Line Conditioning: VFD shall have an integral 5% impedance line reactor to reduce the harmonics to the power line. The impedance may be from dual (positive and negative DC bus) reactors, or 5% AC line reactors.

L. VFD Output Filtering: Provide output filters when wire length from drive to motor exceeds manufacturer's allowable length. Filters shall be equal to KLC dv/dt Guard, U.L. Listed, in NEMA 1 enclosure.

M. Status Lights: Door-mounted LED indicators shall indicate the following conditions:
1. Power on – normal operation.
2. Fault.
3. Alarm control

N. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual speed control potentiometer and real time clock.

1. Indicating Devices: Digital LED readout and selector switch, to indicate the following controller parameters:

a. Output frequency (Hz).

b. Motor speed (rpm).

c. Motor status (running, stop, fault).

d. Motor current (amperes).

e. Motor torque (percent).

f. Fault or alarming status (code).

g. PID feedback signal (percent).

h. DC-link voltage (VDC).

i. Set-point frequency (Hz).

j. Motor output voltage (V).

O. Control Signal Interface:

1. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.

2. Remote Signal Inputs: Capability to accept any of the following speed setting input signals from the BMS or other control systems:

a. 0 to 10-V dc.

b. 0-20 or 4-20 mA.

c. Potentiometer using up/down digital inputs.

d. Fixed frequencies using digital inputs (Fireman's override).

e. RS485.

f. Keypad display for local hand operation.

3. Output Signal Interface:

a. A minimum of 2 analog output signal (0/4-20 mA), which can be programmed to any of the following:

1) Output frequency (Hz).

2) Output current (load).

3) DC-link voltage (VDC).

4) Motor torque (percent).

5) Motor speed (rpm).

6) Set-point frequency (Hz).

4. Remote Indication Interface: A minimum of 3 dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:

a. Motor running.

b. Fault and warning indication (overtemperature or overcurrent).

c. Loss of load condition (broken belt / broken coupling).

P. Communications: Provide an RS485 interface allowing VFD to be used with an external system within a multidrop LAN configuration. Interface shall allow all parameter settings of VFD to be programmed via BAS control. Provide capability for VFD to retain these settings within the nonvolatile memory.

1. Coordinate requirements with controls diagrams and controls contractor to provide BACnet MS/TP interface.
2. Disconnecting Means: Provide VFD's without disconnects.

2.3 ENCLOSURES

A. NEMA Type 1 for general purpose interior dry locations.

B. NEMA Type 3R for exterior or damp locations.

2.4 ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.

PART 3 - EXECUTION

3.1 Applications

A. Select features of each VFD to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; and duty cycle of motor, controller and load.

B. Select horsepower rating of controllers to suit motor(s) controlled. For VFD's serving multiple motors, size VFD according to the sum of the RLA's of all motors.

3.2 Installation

A. Anchor each VFD assembly to steel-channel sills arranged and sized according to manufacturer's written instructions. Attach by bolting. Level and grout sills flush with mounting surface.

B. Controller Fuses: Install fuses in each fusible switch.

3.3 Control Wiring Installation

A. Connect hand-off-automatic switch and other automatic-control devices where applicable.

1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
2. Connect selector switches with control circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.4 Connections

A. Conduit installation requirements are specified in Division 26 Sections.

B. Ground equipment according to Division 26.

3.5 Field Quality Control

A. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following check-out and start-up services:

1. Inspect controllers, wiring, components, connections, and equipment installation. For proper operation and installation of VFD, its options and interface wiring to the BAS.
2. Set field-adjustable switches and circuit breaker trip ranges.
3. Report results in writing.

3.6 Demonstration

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain variable frequency drives.

Section 25 35 30 – Integrated Automation System Tubing, Cabling and Raceway

PART 1 - GENERAL

1.1 Related Sections

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Section 25 05 01, Integrated Automation System General Requirements

C. Section 25 05 02, Integrated Automation System Submittals

D. Section 25 05 03, Integrated Automation System Project Record Documents

E. Section 25 05 04, Integrated Automation System Start-Up, Verification and Commissioning

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L. Section 25 35 19, Integrated Automation System Control Valves

M. Section 25 35 27, Integrated Automation System Variable Frequency Drives

PART 2 - PRODUCTS

2.1 Piping and Tubing

A. Pressure Instrument Tubing and Piping:

1. Products in this paragraph are intended for use with the following:
2. Signal air between pressure instruments, such as sensors, switches, transmitters, controllers and accessories.
3. Copper Tubing:
    a. Seamless phosphor deoxidized copper, soft annealed or drawn tempered, with chemical and physical properties according to ASTM B 75.
    b. Performance, dimensions, weight and tolerance according to ASTM B 280.
    c. Diameter, as required by application, not less than nominal 0.25 inch.
    d. Wall thickness, as required by the application, but not less than 0.030 inch.
4. Copper Tubing Connectors and Fittings:
    a. Brass, compression type.
5. Polyethylene Tubing:
    a. Fire-resistant black virgin polyethylene according to ASTM D 1248, Type 1,
    b. Class C and Grade 5.
    c. Tubing shall comply with stress crack test according to ASTM D 1693.
    d. Diameter, as required by application, of not less than nominal 0.25 inch.

6. Polyethylene Tubing Connectors and Fittings:
    a. Brass, barbed fittings.
    b. Brass, compression type.

B. Process Tubing:
1. Products in this paragraph are intended for signals to instruments connected to liquid and steam systems.
2. Copper Tubing:
    a. Seamless phosphor deoxidized copper, soft annealed or drawn tempered with chemical and physical properties according to ASTM B 75.
    b. Performance, dimensions, weight and tolerance according to ASTM B 280.
    c. Diameter, as required by application, of not less than nominal 0.25 inch.
    d. Wall thickness, as required by application, but not less than 0.030 inch.
3. Copper Tubing Connectors and Fittings:
    a. Brass, compression type.
4. Stainless-Steel Tubing:
    a. Seamless Type 316 stainless steel, Grade TP, cold drawn, annealed and pickled, free from scale.
    b. Chemical and physical properties according to ASTM A 269.
    c. Diameter, as required by application, of not less than nominal 0.25 inch.
    d. Wall thickness, as required by application, but not less than 0.035 inch.
    e. Furnish stainless-steel tubing in 20-foot straight random lengths.
5. Stainless-Steel Tubing Connectors and Fittings:
    a. Connectors and fittings shall be stainless steel, with stainless-steel collets, flareless type.
    b. Connect instruments to tubing with connectors having compression connector on one end and IPS or NPT thread on another end.

2.2 Control Wire and Cable

A. Wire: Single or Multiconductor control wire cables:
1. Wire size shall be at least No. 18 AWG.
2. Conductor shall be 7/24 soft annealed copper strand with 2- to 2.5-inch lay.
3. Conductor insulation shall be 600 V, Type THWN or Type THHN, and 90 deg C with plenum rated outer jacket.
4. Furnish wire on spools.

B. Single Twisted Shielded Instrumentation Cable above 24 V:
1. Wire size shall be a minimum No. 18 AWG.
2. Conductors shall be a twisted, 7/24 soft annealed copper strand with a 2- to 2.5-inch lay.
3. Conductor insulation shall have a Type THHN/THWN or Type TFN rating.
4. Shielding shall be 100 percent type, 0.35/0.5-mil aluminum/Mylar tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
5. Outer jacket insulation shall have a 600-V, 90-deg C rating and shall be plenum rated.

6. For twisted pair, conductor colors shall be black and white.
7. Furnish wire on spools.

C. Single Twisted Shielded Instrumentation Cable 24 V and Less:

1. Wire size shall be a minimum No. 18 AWG.
2. Conductors shall be a twisted, 7/24 soft annealed copper stranding with a 2- to 2.5-inch lay.
3. Conductor insulation shall have a nominal 15-mil thickness.
4. Shielding shall be 100 percent type, 1.35-mil aluminum/polymer tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire. Outer jacket insulation shall have a 300-V, 105-deg C rating and shall be plenum rated.
5. For twisted pair, conductor colors shall be black and white.
6. Furnish wire on spools.

2.3 Raceways for Control Wiring, Cabling and Tubing

A. Metal Conduits, Tubing, and Fittings:

1. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. GRC: Comply with NEMA ANSI C80.1 and UL 6.
3. EMT: Comply with NEMA ANSI C80.3 and UL 797.
4. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
5. Fittings for Metal Conduit: Comply with NEMA ANSI FB 1 and UL 514B.
    a. Fittings for EMT:
        1) Material: Steel.
        2) Type: Setscrew.
    b. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
    c. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.
6. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

B. Surface Metal Raceways: ** USE ONLY WHERE SPECIFICALLY SHOWN OR PLANS OR AUTHORIZED BY OWNER. OTHERWISE ALL CONTROL CABLE TO BE CONCEALED IN THE WALL CONSTRUCTION. Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color as selected by Owner.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    a. MonoSystems, Inc.
    b. Panduit Corp.
    c. Wiremold / Legrand.

C. Control Power Wiring and Raceways

1. Comply with requirements in Division 26 for electrical power conductors and cables.
2. Comply with requirements in Division 26 for electrical power raceways and boxes.

PART 3 - EXECUTION

3.1 Control Wire, Cable and Raceways Installation

A. Comply with NECA 1.

B. Comply with TIA 568-C.1.

C. Wiring Method: Install cables in raceways except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for cable trays specified in [Section 260536 "Cable Trays for Electrical Systems."]
3. Comply with requirements for raceways and boxes specified in [Section 260533 "Raceways and Boxes for Electrical Systems."]

D. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

E. Field Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

F. Conduit Installation:

1. Install conduit expansion joints where conduit runs exceed 200 feet, and conduit crosses building expansion joints.
2. Coordinate conduit routing with other trades to avoid conflicts with ducts, pipes and equipment and service clearance.
3. Maintain at least 3-inch separation where conduits run axially above or below ducts and pipes.
4. Limit above-grade conduit runs to 100 feet without pull or junction box.
5. Do not install raceways or electrical items on any "explosion-relief" walls, or rotating equipment.
6. Do not fasten conduits onto the bottom side of a metal deck roof.
7. Flexible conduit is permitted only where flexibility and vibration control is required.
8. Limit flexible conduit to 3 feet long.
9. Conduit shall be continuous from outlet to outlet, from outlet to enclosures, pull and junction boxes, and shall be secured to boxes in such manner that each system shall be electrically continuous throughout.
10. Secure threaded conduit entering an instrument enclosure, cabinet, box, and trough, with a locknut on outside and inside, such that conduit system is electrically continuous throughout. Provide a metal bushing on inside with insulated throats. Locknuts shall be the type designed to bite into the metal or, on inside of enclosure, shall have a grounding wedge lug under locknut.
11. Conduit box-type connectors for conduit entering enclosures shall have an insulated throat.
12. Connect conduit entering enclosures in wet locations with box-type connectors or with watertight sealing locknuts or other fittings.
13. Offset conduits where entering surface-mounted equipment.

14. Seal conduit runs used by sealing fittings to prevent the circulation of air for the following:
    a. Conduit extending from interior to exterior of building.
15. Conduit extending into pressurized duct and equipment.
16. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.

G. Wire and Cable Installation:

1. Cables serving a common system may be grouped in a common raceway. Install control wiring and cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.
2. Install cables with protective sheathing that is waterproof and capable of withstanding continuous temperatures of 90 deg C with no measurable effect on physical and electrical properties of cable.
    a. Provide shielding to prevent interference and distortion from adjacent cables and equipment.
3. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
4. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
5. Unshielded Twisted Pair (UTP) Cable Installation:
    a. Comply with TIA 568-C.2.
    b. Do not untwist UTP cables more than 1/2 inch from the point of termination, to maintain cable geometry.
6. Installation of Cable Routed Exposed under Raised Floors:
    a. Install plenum-rated cable only.
7. Identify each wire on each end and at each terminal with a number-coded identification tag. Each wire shall have a unique tag.
8. Provide strain relief.
9. Terminate wiring in a junction box.
    a. Clamp cable over jacket in junction box.
    b. Individual conductors in the stripped section of the cable shall be slack between the clamping point and terminal block.
10. Terminate field wiring and cable not directly connected to instruments and control devices having integral wiring terminals using terminal blocks.
11. Install signal transmission components according to IEEE C2, REA Form 511a, NFPA 70, and as indicated.
12. Keep runs short. Allow extra length for connecting to terminal boards. Do not bend flexible coaxial cables in a radius less than 10 times the cable OD. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.
13. Ground wire shall be copper and grounding methods shall comply with IEEE C2. Demonstrate ground resistance.
14. Wire and cable shall be continuous from terminal to terminal without splices.
15. Use insulated spade lugs for wire and cable connection to screw terminals.

16. Use shielded cable to transmitters.
17. Use shielded cable to temperature sensors.
18. Perform continuity and megger testing on wire and cable after installation.
19. Do not install bruised, kinked, scored, deformed, or abraded wire and cable. Remove and discard wire and cable if damaged during installation, and replace it with new cable.
20. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
21. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
22. Protection from Electro-Magnetic Interference (EMI): Provide installation free of (EMI). As a minimum, comply with the following requirements:
    a. Comply with BICSI TDMM and TIA 569-C for separating unshielded cable from potential EMI sources, including electrical power lines and equipment.
    b. Separation between open cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
        1) Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
        2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
        3) Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
23. Separation between cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
24. Separation between cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
    a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
25. Separation between Cables and Electrical Motors and Transformers, 5 kVA or 5 HP and Larger: A minimum of 48 inches.
26. Separation between Cables and Fluorescent Fixtures: A minimum of 5 inches.

H. BACnet MS/TP Sub-Networks

1. When using MS/TP, provide MS/TP networks in accordance with ASHRAE 135 and in accordance with the ASHRAE 135 figure "Mixed Devices on 3-Conductor Cable with Shield" (Figure 9-1.4 in the 2012 version of ASHRAE 135). Ground the shield at the BACnet Router and at no other point. Ground the reference wire at the BACnet Router through a 100 ohm resistor and do not ground it at any other point.
2. Provide each segment in a doubly terminated bus topology in accordance with TIA-485.
3. Provide each segment with 2 sets of network bias resistors in accordance with ASHRAE 135, with one set of resistors at each end of the MS/TP network.
4. Use 3 wire (twisted pair and reference) with shield media for all MS/TP media installed inside. Use fiber optic isolation in accordance with ASHRAE 135 for all MS/TP media installed outside buildings, or between multiple buildings.

5. For 18 AWG cable, use segments with a maximum length of 4000 ft. When using greater distances or different wire gauges comply with the electrical specifications of TIA-485.
6. For each controller that does not use the reference wire provide transient suppression at the network connection of the controller if the controller itself does not incorporate transient suppression.
7. Install no more than 32 devices on each MS/TP segment. Do not use MS/TP to MS/TP routers.
8. For BACnet Routers, configure the MS/TP MAC address to 0. Assign MAC Addresses to other devices consecutively beginning at 1, with no gaps.

- End -