

То:	Prospective Bidders
From:	Wold Architects and Engineers
Date:	February 24, 2023
Comm. No:	213106
Subject:	Addendum No. 2 for Bidding Documents for the Regional Operations and Communications Facility Libertyville, Illinois

y .

BIDS DUE MARCH 9, 2023, AT 11:00 A.M.

This addendum forms a part of the Contract Documents dated December 30, 2022. Acknowledge receipt of this Addendum on the space provided on the Bid Form. Failure to do so may result in disqualification of Bid.

This Addendum consists of six (5) typed sheets and attachments:

Specifications: 00 01 10 – Book 1, 00 01 10 – Book 2, 01 30 00, 01 32 50, 21 10 00, 21 22 00, 21 31 13, 22 11 14, 22 11 16, 23 09 00, 23 09 50, 23 21 23, 23 34 16, 23 36 00, 23 52 21, 23 64 30, 23 73 13, 23 81 23, 23 82 19, 23 84 13, 25 00 00, 26 05 26, 26 09 23, 26 24 13, 26 24 16, 26 27 13, 26 28 16, 26 32 13, 26 33 53, 26 33 56, 26 36 00, 26 51 00, 28 31 11

Drawings: C4, A2.01a, A2.01b, A3.01a, A3.01b, A4.403, M2.01, M2.02, M3.01, M3.02, M5.01, M6.10, M6.17, E0.01, E0.02, E1.11a, E2.11a, E2.11b, E3.11a, E5.01, E5.10, E5.11, E5.20, E6.01, E6.02, E6.12, E6.13. E7.01

PROJECT MANUAL

- 1. SPECIFICATION SECTION 00 01 10 TABLE OF CONTENTS BOOK 1 A. Reissued this addendum.
- 2. SPECIFICATION SECTION 00 01 10 TABLE OF CONTENTS BOOK 2 A. Reissued this addendum.
- **3. SPECIFICATION SECTION 01 30 00 ADMINISTRATIVE REQUIREMENTS** A. Reissued this addendum.
- 4. SPECIFICATION SECTION 01 32 50 BUILDING INFORMATION MODEL (BIM) AND PROVISION OF ELECTRONIC SUBMITTAL DATA
 - A. Issued this addendum.

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- 5. SPECIFICATION SECTION 21 10 00 WATER-BASED FIRE SUPPRESSION SYSTEMS A. Reissued this addendum.
- 6. SPECIFICATION SECTION 21 22 00 CLEAN AGENT FIRE SUPPRESSION SYSTEM A. Reissued this addendum.
- 7. SPECIFICATION SECTION 21 31 13 ELECTRIC DRIVE, CENTRIFUGAL FIRE PUMPS A. Reissued this addendum.
- 8. SPECIFICATION SECTION 22 11 14 DOMESTIC WATER PACKAGED BOOSTER PUMPS

A. Reissued this addendum.

- **9. SPECIFICATION SECTION 22 11 16 DOMESTIC WATER PIPING** A. Reissued this addendum.
- **10. SPECIFICATION SECTION 23 09 00 BUILDING AUTOMATION SYSTEM** A. Reissued this addendum.
- 11. SPECIFICATION SECTION 23 09 50 VARIABLE FREQUENCY MOTOR CONTROLLERS
 - A. Reissued this addendum.
- **12. SPECIFICATION SECTION 23 21 23 HYDRONIC PUMPS** A. Reissued this addendum.
- **13. SPECIFICATION SECTION 23 34 16 AIR HANDLING** A. Reissued this addendum.
- **14. SPECIFICATION SECTION 23 36 00 AIR TERMINAL UNITS** A. Reissued this addendum.
- **15. SPECIFICATION SECTION 23 52 21 ELECTRIC BOILERS** A. Reissued this addendum.
- 16. SPECIFICATION SECTION 23 64 30 GEOTHERMAL WATER-TO-WATER HEAT PUMPS
 - A. Reissued this addendum.
- **17. SPECIFICATION SECTION 23 73 13 CENTRAL-STATION AIR-HANDLING UNITS** A. Reissued this addendum.
- **18. SPECIFICATION SECTION 23 81 23 COMPUTER ROOM AIR-CONDITIONERS** A. Reissued this addendum.
- **19. SPECIFICATION SECTION 23 82 19 FAN COIL UNITS** A. Reissued this addendum.
- 20. SPECIFICATION SECTION 23 84 13 HUMIDIFIERS WITH WATER TREATMENT SYSTEM
 - A. Reissued this addendum.
- 21. SPECIFICATION SECTION 25 00 00 INTEGRATED AUTOMATION
 - A. Alterations to specification as noted
- 22. SPECIFICATION SECTION 25 00 00 BACNET SINGLE LINE DIAGRAM AND RESPONSIBILITY MATRIX
 - A. Reissued this addendum.
- 23. SPECIFICATION SECTION 26 09 23 LIGHTING CONTROL SYSTEM



- A. Reissued this addendum.
- **24. SPECIFICATION SECTION 26 24 13 SWITCHBOARDS** A. Reissued this addendum.
- 25. SPECIFICATION SECTION 26 24 16 PANELBOARDS
 - A. Reissued this addendum.
- **26. SPECIFICATION SECTION 26 27 13 ELECTRICITY METERING** A. Reissued this addendum.
- 27. SPECIFICATION SECTION 26 28 16 ENCLOSED SWITCHES AND CIRCUIT BREAKERS
 - A. Reissued this addendum.
- 28. SPECIFICATION SECTION 26 32 13 ENGINE GENERATORS
 - A. Reissued this addendum.
- **29. SPECIFICATION SECTION 26 33 53 STATIC UNINTERRUPTIBLE POWER SUPPLY** A. Reissued this addendum.
- 30. SPECIFICATION SECTION 26 33 56 EMERGENCY LIGHTING INVERTER
- A. Reissued this addendum.31. SPECIFICATION SECTION 26 36 00 TRANSFER SWITCHES
 - A. Reissued this addendum.
- **32. SPECIFICATION SECTION 26 51 00 LIGHTING** A. Reissued this addendum.
- 33. SPECIFICATION SECTION 28 31 11 FIRE ALARM SYSTEMS
 - A. Reissued this addendum.

PRIOR APPROVALS

The following schedule amends designated specification sections to list additional acceptable manufacturers. Use of any product by any of these manufacturers will be permitted only if after review of shop drawings or detailed product data per Section 01 33 00, Architect determines that proposed materials or equipment are equivalent in performance, construction and appearance to product(s) specified.

Where anticipated product substitutions would alter the design or space requirements indicated on the Drawings, pay for cost of design and construction revisions including the cost of associated work by other contractors.

For complete requirements, see Specification Section 01 25 00 – Substitutions and Product Options.

Section No. Item Type Acceptable Manufacturer



DRAWINGS

- 1. DRAWING C4 GEOMETRIC PLAN
 - A. Reissued this addendum.
- DRAWING A2.01a FLOOR PLAN AREA 'A' A. Reissued this addendum.
- DRAWING A2.01b FLOOR PLAN AREA 'B' A. Reissued this addendum
- 4. DRAWING A3.01a REFLECTED CEILING PLAN AREA 'A'
 A. Reissued this addendum
- DRAWING A3.01b REFLECTED CEILING PLAN AREA 'B'
 A. Reissued this addendum
- 6. DRAWING A4.403 INTERIOR ELEVATIONSA. Reissued this addendum
- DRAWING M2.01 HYDRONIC AND BAS PLAN AREA 'A' A. Reissued this addendum.
- DRAWING M2.02 HYDRONIC AND BAS PLAN AREA 'B' A. Reissued this addendum.
- 9. DRAWING M3.01 HVAC PLAN AREA 'A' A. Reissued this addendum.
- 10. DRAWING M3.02 HVAC PLAN AREA 'B'
 - A. Reissued this addendum.
- **11. DRAWING M5.01 FIRE PROTECTION PLAN** A. Reissued this addendum.
- **12. DRAWING M6.10 BOILER ROOM AND MECHANICAL PLAN** A. Reissued this addendum.
- **13. DRAWING M6.17 MECHANICAL ROOM SECTION VIEWS** A. Reissued this addendum.
- 14. DRAWING E0.01 ELECTRICAL CAMPUS SITE PLAN OUTSIDE PLANT FIBER AND PATHWAY
 - A. Reissued this addendum.
- 15. DRAWING E0.02 ELECTRICAL SITE PLAN
 - A. Reissued this addendum.
- **16. DRAWING E1.11a MAIN LEVEL LIGHTING PLAN AREA 'A'** A. Reissued this addendum.
- 17. DRAWING E2.11a MAIN LEVEL POWER & FIRE ALARM PLAN AREA 'A'A. Reissued this addendum.
- 18. DRAWING E2.11b MAIN LEVEL POWER & FIRE ALARM PLAN AREA 'B' B. Reissued this addendum.
- 19. DRAWING E3.11a MAIN LEVEL SYSTEMS PLANS AREA 'A'
 - A. Reissued this addendum.



- **20. DRAWING E5.01 ONE-LINE DIAGRAM** A. Reissued this addendum.
- **21. DRAWING E5.10 GROUNDING PLANS** A. Reissued this addendum.
- **22. DRAWING E5.11 GROUNDING DETAILS** A. Reissued this addendum.
- **23. DRAWING E5.20 LIGHTING PROTECTION** A. Reissued this addendum.
- **24. DRAWING E6.01 LUMINAIRE SCHEDULE** A. Reissued this addendum.
- 25. DRAWING E6.02 MOTOR SCHEDULE
 - A. Reissued this addendum.
- **26. DRAWING E6.12 PANEL SCHEDULES** A. Reissued this addendum.
- 27. DRAWING E6.13 PANEL SCHEDULES A. Reissued this addendum.
- 28. DRAWING E7.01 ELECTRICAL DETAILS
 - A. Reissued this addendum.

END OF ADDENDUM #2

SECTION 00 01 10

TABLE OF CONTENTSBOOK 1 OF 3

Section No.	Title		
County Provided Documents	Lake County Bid Solicitation		
Division 00	Procurement and Contracting Requirements		
00 01 01	Project Title Page		
00 01 03	Project Directory		
00 01 05	Certifications Page		
00 01 10	Table of Contents		
Bidding Requirements			
00 31 32	Geotechnical Data		
00 31 35	Stormwater Pollution Prevention Plan		
00 41 00	Bid Form (also reference Lake County Bid Solicitation)		
General Conditions of the Contract			
00 73 43	State Prevailing Wages		
Division 01	General Requirements		
01 10 00	Summary of the Work		
01 21 00	Allowances (also reference Lake County Bid Solicitation)		
01 22 00	Unit Prices (also reference Lake County Bid Solicitation)		
01 23 00	Alternates (also reference Lake County Bid Solicitation)		
01 25 00	Substitution Procedures		
01 25 01	Pre-Bid Substitution Request Form		
01 26 63	Change Orders (also reference Lake County Bid Solicitation)		
01 30 00	Administrative Requirements		
01 31 13.13	Device Interfaces		
01 31 26	Electronic Background Documents		
01 31 27	Electronic Background Documents – Attachment A		
01 32 16	Construction Progress Schedule		
01 32 50	Building Information Model (BIM) and Provision of Electronic Submittal Data		
01 45 16	Quality Control Testing		
01 45 16.1	Contractor Quality Assurance Plan for Storm Shelters		
01 45 33	Structural Testing and Special Inspection		
01 50 00	Temporary Facilities and Controls		
01 70 00	Execution and Closeout Requirements		
01 74 19	Sustainable Waste Management and Disposal		
01 78 00	Closeout Submittals		
01 79 00	Demonstration and Training		
01 81 13	Sustainable Design Requirements – LEED v4 BD+C		
01 91 13	General Commissioning Requirements		
01 91 15	Building Enclosure Commissioning		
Division 02	Exterior Conditions		
02 31 00	Ornamental Cantilever Gate System		
02 31 19	Ornamental Fence and Gate System		

Section No.	Title
Division 03	Concrete
03 10 00	Concrete Forming and Accessories
03 15 10	Post-Installed Anchors
03 20 00	Concrete Reinforcing
03 30 00	Cast-In-Place Concrete
03 35 11	Concrete Floor Finishes
Division 04	Masonry
04 20 00	Non-Bearing Unit Masonry
04 27 31	Reinforced Unit Masonry
Division 05	Metals
05 12 00	Structural Steel Framing
05 21 00	Steel Joist Framing
05 31 00	Steel Decking
05 40 00	Cold-Formed Metal Framing
05 50 00	Metal Fabrications
Division 06	Wood, Plastics and Composites
06 10 53	Rough Carpentry-Wood Blocking
06 16 43	Gypsum Sheathing
06 83 16	Fiberglass Reinforced Paneling-FRP
Division 07	Thermal and Moisture Protection
07 05 53	Fire and Smoke Assembly Identification
07 13 00	Sheet Waterproofing
07 21 00	Insulation
07 21 19	Spray Foam Insulation
07 25 00	Weather Barriers
07 42 13	Metal Wall Panels
07 42 13.23	Rainscreen Aluminum Composite Material Wall Panels
07 46 46	Fiber Reinforced Cementitious Panels
07 53 00 07 54 23	EPDM Membrane Roofing
07 54 25	Thermoplastic Membrane Roofing Sheet Metal Roofing
07 62 00	Sheet Metal Coping and Flashing
07 72 00	Roof Accessories
07 84 00	Firestopping
07 91 00	Preformed Joint Seals
07 92 00	Joint Sealants
07 95 13	Expansion Joint Cover Assemblies
Division 08	Openings
08 11 13	Hollow Metal Doors and Frames
08 14 16	Flush Wood Doors
08 16 13	Fiberglass Doors and Frames
08 31 00	Access Panels
08 33 23	Overhead Coiling Doors
08 44 13	Aluminum Storefront, Entrances and Curtainwalls
08 56 56	Storm Shelter Windows and Doors
08 71 00	Finish Hardware
08 80 00	Glazing
08 91 00	Louvers

Section No.	<u>Title</u>
Division 09	<u>Finishes</u>
09 05 61	Common Work Results for Floor Preparation
09 21 16	Gypsum Wallboard Assemblies
09 30 00	Tile
09 51 00	Acoustical Ceilings
09 54 43	Stretched Fabric Ceiling
09 65 00	Resilient Flooring
09 68 13	Carpet Flooring
09 69 00	Access Flooring
09 72 00	Wall Coverings
09 78 00	Prefinished Interior Panels
09 84 30	Acoustical Panels
09 90 00	Painting and Coating
Division 10	<u>Specialties</u>
10 11 00	Visual Display Boards
10 14 00	Signage
10 21 13.19	Plastic Toilet Partitions
10 26 13	Corner Protection
10 28 00	Toilet Accessories
10 44 00	Fire Protection Specialties
10 75 00	Flagpoles
Division 11	<u>Equipment</u>
11 12 33	Slide Gate Operator
11 13 19	Loading Dock Equipment
Division 12	Furnishings
12 24 00	Window Shades
12 32 00	Casework
Division 13	Not Used
Division 14	Conveying Equipment
14 12 00	Electric Hoists
Division 15-20	Not Used
Division 21-49	See Book 2

SECTION 00 01 10

PROJECT MANUAL TABLE OF CONTENTS BOOK 2 OF 3

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21 05 00	Common Work Results for Fire Suppression
21 05 05	BACnet and Other Device Interfaces Integration (by Owner Consultant)
21 10 00	Water-Based Fire-Suppression Systems
21 22 00	Clean-Agent Fire Suppression Systems
21 31 13	Electric Drive, Centrifugal Fire Pumps
21 40 00	Corrosion Management System
Division 22	Plumbing
22 05 00	Common Work Results For Plumbing
22 05 05	BACnet and Other Device Interfaces Integration (by Owner Consultant)
22 05 19	Meters and Gages For Plumbing Piping
22 05 23	General-Duty Valves For Plumbing Piping
22 05 29	Hangers And Supports For Plumbing Piping and Equipment
22 05 53	Identification For Plumbing Piping and Equipment
22 07 00	Plumbing Insulation
22 11 14 22 <i>11 24</i>	Domestic Water Packaged Booster Pumps
22 11 16	Domestic Water Piping
22 11 19	Domestic Water Piping Specialties
22 11 23	Domestic Water Pumps
22 13 16	Sanitary Waste And Vent Piping
22 13 19	Sanitary Waste Piping Specialties
22 33 00	Heat Pump Water Heaters
22 40 00	Plumbing Fixtures
Division 23	Heating, Ventilating and Air Conditioning
23 05 00	Common Work Results For HVAC
23 05 05	BACnet and Other Device Interfaces Integration (by Owner Consultant)
23 05 13	Common Motor Requirements For HVAC Equipment
23 05 19	Meters And Gages For HVAC Piping
23 05 23	General-Duty Valves For HVAC Piping
23 05 29	Hangers And Supports For HVAC Piping And Equipment
23 05 53	Identification For HVAC Piping And Equipment
23 07 00	HVAC Insulation
23 09 00	Building Automation System
23 09 50	Variable Frequency Motor Controllers
23 09 93	BAS Sequence of Operations
23 21 13	Hydronic Piping
23 21 14	Ground-Loop Heat-Pump Piping
23 21 23	Hydronic Pumps
23 23 00	Refrigerant Piping
23 31 13	Ductwork
23 33 00	Air Duct Accessories
23 34 16	Air Handling
23 36 00	Air Terminal Units
23 37 13	Diffusers, Registers, and Grilles
23 37 23	HVAC Gravity Ventilators
23 52 21	Electric Boilers

<u>Section No.</u>	<u>Title</u>	
Division 23	Heating, Ventilating and Air Conditioning	
23 64 30	Geothermal Water-to-Water Heat Pumps	
23 73 13	Central-Station Air-Handling Units	
23 81 23	Computer-Room Air-Conditioners	
23 82 19	Fan Coil Units	
23 82 33	Heating Terminal Units	
23 84 13	Humidifiers with Water Treatment System	
23 90 00	Testing, Adjusting, and Balancing	
Division 24	Not Used	
Division 25	See Book 3	
Division 26	Electrical	
26 05 00	Common Work Results for Electrical	
26 05 05	526.164.ROCB Device Interfaces - ROC Facility V0	1 IFB Set BACnet and Other
20 05 05	Device Interfaces Integration	
26 05 19	Electrical Power Conductors	
26 05 23	Electric Heat Trace	
26 05 26	Grounding and Bonding for Electrical Systems	
26 05 29	Hangers and Supports for Electrical Systems	
26 05 33	Raceway and Boxes for Electrical Systems	
26 05 36	Cable Trays for Electrical Systems	
26 05 43	Underground Ducts and Raceways for Elec Systems	
26 05 53	Identification for Electrical Systems	
26 05 73	Overcurrent Protective Device Coordination Study	
26 08 00	Commissioning of Electrical Systems	
26 09 23	Lighting Control System	
26 22 00	Low-Voltage Transformers	
26 22 00	Switchboards	
26 24 16	Panelboards	
26 25 00	Enclosed Bus Assemblies	
26 26 53	Electric Vehicle Charging Equipment	
26 27 01	Electrical Utility Coordination	
26 27 13	Electricity Metering	
26 27 26	Wiring Devices	
26 28 13	Fuses	
26 28 16	Enclosed Switches and Circuit Breakers	
26 32 13	Engine Generators	
26 33 53	Static Uninterruptible Power Supply	
26 33 56	Emergency Lighting Inverter	
26 35 50 26 36 00	Transfer Switches	
26 36 50	Portable Generator Docking Stations	
26 41 13	Lightning Protection for Structures	
26 43 13	Surge Protection Devices	
26 51 00	Lighting	
26 70 00	Raceway for Low Voltage Systems	
Division 27	Communications	
27 05 00	Common Work Results for Communications	
27 11 00	Communications Equip Room Fittings	
27 13 00	Communications Backbone Cabling	
27 15 00	Communications Horizontal Cabling	
27 17 00	Common Work Results for Outside Plant Communication	ons
27 17 01	Outside Plant Pathway and Spaces	
No. 213106	00 01 10-2	Table of Contents – Book 2

<u>Title</u>
Communications
Outside Plant Fiber Optic Cable
Audio / Video System
Sound Masking Systems
Wireless Master Clock System
Electronic Safety and Security
526.164.ROCB Device Interfaces - ROC Facility V01 IFB Set
Access Control
Video Surveillance
Fire Alarm Systems
Not Used

SECTION 01 30 00 ADMINISTRATIVE REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A General administrative requirements.
- B Electronic document submittals
 - 1. Construction Project Management Software
- C Preconstruction meeting.
- D Progress meetings.
- E Schedule of Values.
- F Contractor's daily reports.
- G Progress photographs.
- H Coordination drawings.
- I Submittals for review and information.
- J Requests for Information (RFI) procedures.
- K Submittal procedures.
- L Building Information Modeling (BIM) and provision of electronic BIM submittal data.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 ELECTRONIC DOCUMENT SUBMITTAL

- A All documents transmitted for purposes of administration of the contract are to be in electronic (PDF) format, as appropriate to the document, and transmitted via email the architect's staff assigned to the project.
 - 1. Besides submittals for review, information, and closeout, this procedure applies to Requests for Information (RFIs), progress documentation, contract modification documents (e.g. supplementary instructions, change proposals, change orders), applications for payment, field reports and meeting minutes, Contractor's correction punchlist, and any other document any participant wishes to make part of the project record.
 - 2. It is Contractor's responsibility to submit documents in allowable format.
 - 3. All other specified submittal and document transmission procedures apply, except that electronic document requirements do not apply to samples or color selection charts.
- B Contractor is required to conduct project management with an industry standard project management software. Project Management Software must allow for:
 - 1. Document management of all items listed in this specification during the construction process
 - 2. Be available for Owner, Architect, Consultants, and Vendors use throughout construction.
 - 3. Provide a full download of archive documents at close out of the project.
 - 4. Provide the Owner and Architect the ability to set up workflows.
- C If the Owner elects to provide their own project management software, Bidder shall work with the Owner to implement workflows as required to achieve Bullets A and B above.

3.02 LIST OF MATERIALS

- A Within 7 days after the award of the Contract (notice to proceed or letter of intent), submit a complete list electronically of all material, products, and equipment proposed to be used in construction to the Architect for acceptance.
 - 1. Do not order materials until the proposed listed materials, products and equipment to be used in construction are accepted by the Architect.

- B Where two or more makes or kinds of items are named in the specifications (or additional names are called for in addenda), the Contractor shall state which particular make or kind of each item they proposes to provide. If the Contractor fails to state a preference, the Owner shall have the right to select any of the makes or kinds named without change in price.
- C This list shall be arranged generally in order of specification sections. The items listed shall fully conform to project requirements and specifications. All materials are subject to the Architect's acceptance.
 - 1. After acceptance, changes or substitutions will not be permitted.
- D Clearly identify or list the material, product or equipment by manufacturer and brand by listing the names for all items, including those where only one material or product is specified. Each and every material, product and equipment shall be specifically named, not listed "as specified".

3.03 LIST OF SUBCONTRACTORS

- A Immediately after Contract award submit a subcontractor and supplier list.
 - 1. Propose use of subcontractors or sub-subcontractors who are established, reputable firms of recognized standing with a record of successful and satisfactory past performance. Include the following information: specification section, item of work, subcontractor or supplier, material/manufacturer (as specified will not be allowed), project manager, phone and email. List major sub-subcontractors for mechanical and electrical work. Use only those subcontractors (and sub-sub-contractors, when appropriate) who are acceptable to the Architect and Owner on the Work.

3.04 SCHEDULE OF VALUES

- A Requirements
 - 1. Submit Schedule of Values to Architect ten (10) days prior to first Application For Payment (AIA Form G702, G702a).
 - a. For projects with specific bid allocations included on the bid form, break down Schedule of Values by allocation.
 - b. Break down labor and material separately.
 - c. Round off amounts to nearest ten dollars.
 - d. Provide separate line items for each of the following items:
 - 1) Operations and Maintenance Manuals, equaling of 0.125% of Contract value.
 - 2) As-Built Drawings, equaling of 0.0625% of Contract value.
 - 3) Training, equaling of 0.125% of Contract value.
 - 4) Attic Stock Materials, equaling 0.0625% of Contract value.
 - 5) Mechanical and Electrical Coordination Drawings, equaling 0.0625% of Contract value.
 - 2. Use Schedule of Values only as basis for Contractor's Application For Payment.
- B Form of Submittal
 - 1. Base format on Sections listed in Section 00 01 10 Table of Contents, as well as, the Mechanical and Electrical Table of Contents. Break down labor and material separately.
- C Development with Owner
 - 1. Owner is utilizing multiple funding mechanisms including: capital, bonds, grants, and 3rd party contributions in the financing of this project. Contractor shall work with the Owner to develop a schedule of values in conformance with the various monitoring and reporting requirements associated with these funding streams.
- D Multiple Purchase Order Issuance
 - 1. Owner may issue one or more purchase orders to Bidder for the sum total of the bid award as may be required for tracking and reporting associated with funding streams

2. Bidder shall submit separate invoices against individual purchase orders (including required backup materials) as may be required by owner.

3.05 CONSTRUCTION SCHEDULES

A Refer to Section 01 32 16 Construction Progress Schedule.

3.06 PRECONSTRUCTION MEETING

- A Schedule meeting within 15 days after Notice to Proceed.
- B Attendance Required:
 - 1. Owner's representative.
 - 2. Architect and their consultants.
 - 3. Contractor's Project Manager and Site Superintendent.
 - 4. Major Subcontractors.
 - 5. Major Suppliers.
 - 6. Others as appropriate.
- C Agenda:
 - 1. Distribution and discussion of:
 - a. List of subcontractors.
 - b. List of major suppliers.
 - c. Projected construction schedules.
 - d. Submittal schedule.
 - e. Scheduling of pre-installation conferences.
 - 2. Project coordination and scheduling:
 - a. Designation of responsible personnel representing the Owner, Contractor, Architect and Architect's Consultants.
 - b. Major equipment deliveries and priorities, including expected submittals for such.
 - c. Critical work sequencing.
 - d. Mock-up Panels.
 - e. Temporary utilities.
 - f. Use of onsite utilities.
 - g. NFPA 285 field coordination meeting to ensure that all materials being proposed align with NFPA 285 test reports. Attendance is mandatory for products being installed by the following contractors:
 - 1) Spray foam.
 - 2) Exterior studs.
 - 3) Exterior sheathing and or continuous insulation.
 - 4) Weather barrier.
 - 5) Cladding materials.
 - h. Storm Shelter Quality Assurance Plan.
 - Must proceed any submittals associated with the Strom Shelter.
 - 3. Procedures and processing of: field decisions, submittals, substitutions, applications for payments, proposal request, Change Orders, and Contract closeout procedures.
 - a. Status of Building Permit and:
 - 1) AHJ required development agreements
 - 2) AHJ required bonds and indemnifications
 - 3) Steel Fabricator Certification.
 - 4) Special Inspection Form.
 - b. Field decisions.

1)

- c. Submittals.
 - 1) Mechanical and Electrical Coordination drawings.
- d. Product substitutions.
- e. Applications for payments.
- f. Time limit on claims of 21 days.
- g. Proposal Requests and Supplemental Instructions.
- h. Change Orders.
- i. Scheduling activities of a Geotechnical Engineer.
- 4. Procedures for maintaining Record Documents.
- 5. Use of Premises:
 - a. Office, work and storage areas.
 - b. Owner's requirements.
- 6. Construction facilities, controls and construction aids.
 - a. Construction Dust Control and Periodic Cleaning:
 - 1) Submittal of work area and procedures schedule.
 - 2) Dust proof enclosures.
 - 3) Maintaining negative air flow.
 - 4) Dust control by water mist of surfaces.
 - 5) Debris removal weekly.
 - 6) Daily cleaning requirements.
 - b. Failure to Comply.
 - 1) A written warning will be issued for correction by the Architect.
 - (a) If correction notice is not complied within 8 hours, Owner may take over cleaning.
 - (b) Cost will be back charged to the Contractor(s) by Change Order.
 - c. Final Cleaning:
 - 1) Schedule in time for Owner to complete furniture installation, and cleaning/waxing of floors.
 - 2) Any cleaning done by the Owner due to unacceptable cleaning by the Contractor, or not proceeding in a timely fashion will be back charged to Contractor.
- 7. Contractor to record minutes and distribute copies within two days after meeting to participants, with electronic copies to Architect, Owner, participants, and those affected by decisions made.

3.07 PROGRESS MEETINGS

- A Schedule and administer meetings throughout progress of the work at regular intervals and as required due to the progress of the work.
- B Hold called meetings at the Contractor's project field office.
- C Attendance Required:
 - 1. Contractor.
 - 2. Owner.
 - 3. Architect may attend as needed.
 - 4. Architect' consultants may attend as needed.
 - 5. Contractor's superintendent.
 - 6. Subcontractors appropriate to the progress of the work.
 - 7. Suppliers and manufacturer's representatives as appropriate to the agenda.
- D Agenda:
 - 1. Review and approval of minutes from previous meetings.
 - 2. Review of work progress since previous meeting.
 - 3. Field observations, problems, and decisions.
 - 4. Identification of problems that impede, or will impede, planned progress.

- 5. Review of submittals schedule and status of submittals.
- 6. Review of off-site fabrication and delivery schedules.
- 7. Maintenance of progress schedule.
- 8. Corrective measures to regain projected schedules.
- 9. Planned progress during succeeding work period before the next meeting.
- 10. Maintenance of quality and work standards.
- 11. Effect of proposed changes on progress schedule and coordination.
- 12. Other business relating to work.
- E Contractor to record minutes and distribute copies within two days after meeting to participants, with electronic copies to Architect, Owner, participants, and those affected by decisions made.

3.08 STORM SHELTER QUALITY ASSURANCE PLAN

- A All Contractors providing components to construct the storm shelter shall include a quality assurance plan to the Architect, Structural engineer of record (EOR), Owner and Building Official by the time submittals are sent for review.
 - 1. Submittals preceding a quality assurance plan will be rejected upon receipt.
 - 2. The quality assurance plan shall conform to, and address, the requirements set forth in Section 107.3 of ICC 500. As follows:
 - a. Acknowledgement of awareness of the special requirements contained in the quality assurance plan.
 - b. Acknowledgement that control will be exercised to obtain compliance with the construction documents.
 - c. Procedures for exercising control within the contractor's organization, the method and frequency of reporting and distribution of reports.
 - d. Identification and qualifications of the person(s) exercising such control and their position(s) in the organization.
- B Specification Section 01 45 33.1, Contractor Quality Assurance Plan provides the template for the quality assurance plan to be completed by Contractors.

3.09 DAILY CONSTRUCTION REPORTS

- A Include only factual information. Do not include personal remarks or opinions regarding operations and/or personnel.
 - 1. Prepare a daily construction report recording the following information concerning events at Project site and project progress:
 - a. Date.
 - b. High and low temperatures, and general weather conditions.
 - c. List and count of contractors/ personnel at Project site.
 - d. Material deliveries.
 - e. Safety, environmental, or industrial relations incidents.
 - f. Stoppages, delays, shortages, and losses. Include comparison between scheduled work activities (in Contractor's most recently updated and published schedule) and actual activities.
 - g. Directives and requests of Authority(s) Having Jurisdiction (AHJ).
 - h. Testing and/or inspections performed.

3.12 PROGRESS PHOTOGRAPHS

- A In addition to periodic, recurring views, take photographs of each of the following events:
 - 1. Completion of site clearing.
 - 2. Excavations in progress.
 - 3. Foundations in progress and upon completion.

- 4. Structural framing in progress and upon completion.
- 5. Enclosure of building, upon completion.
- 6. Take photographs as evidence of existing project conditions at the interior and exterior through the duration of the project.

3.13 COORDINATION DRAWINGS

- A Refer to "Common Work Results" in Mechanical and Electrical Specifications for requirements.
- B Prior to construction occurring above grade plane, submit Mechanical/Electrical Coordination Drawings for design team review.

3.14 REQUESTS FOR INFORMATION (RFI)

- A Definition: A request seeking one of the following:
 - 1. An interpretation, amplification, or clarification of some requirement of Contract Documents arising from inability to determine from them the exact material, process, or system to be installed; or when the elements of construction are required to occupy the same space (interference); or when an item of work is described differently at more than one place in Contract Documents.
 - 2. A resolution to an issue which has arisen due to field conditions and affects design intent.
- B Whenever possible, request clarifications at the next appropriate project progress meeting, with response entered into meeting minutes, rendering unnecessary the issuance of a formal RFI.
- C Preparation: Prepare an RFI immediately upon discovery of a need for interpretation of Contract Documents. Failure to submit a RFI in a timely manner is not a legitimate cause for claiming additional costs or delays in execution of the work.
 - 1. Prepare a separate RFI for each specific item.
 - a. Review, coordinate, and comment on requests originating with subcontractors and/or materials suppliers.
 - b. Do Not forward requests which solely require internal coordination between subcontractors.
- D Reason for the RFI: Prior to initiation of an RFI, carefully study all Contract Documents to confirm that information sufficient for their interpretation is definitely not included.
 - 1. Include in each request Contractor's signature attesting to good faith effort to determine from Contract Documents information requiring interpretation.
 - 2. Unacceptable Uses for RFIs: Do not use RFIs to request the following::
 - a. Approval of substitutions (see Section 01 60 00 Product Requirements)
 - b. Changes that entail change in Contract Time and Contract Sum (comply with provisions of the Conditions of the Contract).
 - c. Different methods of performing work than those indicated in the Contract Drawings and Specifications (comply with provisions of the Conditions of the Contract).
 - 3. Improper RFIs: Requests not prepared in compliance with requirements of this section, and/or missing key information required to render an actionable response. They will be returned without a response, with an explanatory notation.
 - 4. Frivolous RFIs: Requests regarding information that is clearly indicated on, or reasonably inferable from, Contract Documents, with no additional input required to clarify the question.
 - a. They will be rejected.
 - b. The Owner reserves the right to assess the Contractor for the costs (on time-and-materials basis) incurred by the Architect, and any of its consultants, due to processing of such RFIs.
- E Content: Include identifiers necessary for tracking the status of each RFI, and information necessary to provide an actionable response.
 - 1. Official Project name and number, and any additional required identifiers established in Contract Documents.
 - 2. Discrete and consecutive RFI number, and descriptive subject/title.

- 3. Issue date, and requested reply date no sooner than 7 working days.
- 4. Reference to particular Contract Document(s) requiring additional information/interpretation. Identify pertinent drawing and detail number and/or specification section number, title, and paragraph(s).
- 5. Annotations: Field dimensions and/or description of conditions which have engendered the request.
- 6. Contractor's suggested resolution: A written and/or a graphic solution, to scale, is required in cases where clarification of coordination issues is involved, for example; routing, clearances, and/or specific locations of work shown diagrammatically in Contract Documents. If applicable, state the likely impact of the suggested resolution on Contract Time or the Contract Sum.
- F Attachments: Include sketches, coordination drawings, descriptions, photos, submittals, and other information necessary to substantiate the reason for the request.
- G Review Time: Architect will respond and return RFIs to Contractor within seven calendar days of receipt. For the purpose of establishing the start of the mandated response period, RFIs received after 12:00 noon will be considered as having been received on the following regular working day.
 - 1. Response period may be shortened or lengthened for specific items, subject to mutual agreement, and recorded in a timely manner in progress meeting minutes.

3.15 SUBMITTAL SCHEDULE

- A Submit to Architect for review a schedule for submittals in tabular format.
 - 1. Submit at the same time as the preliminary schedule specified in Section 01 32 16 Construction Progress Schedule.
 - 2. Coordinate with Contractor's construction schedule and schedule of values.
 - 3. Format schedule to allow tracking of status of submittals throughout duration of construction.
 - 4. Arrange information to include scheduled date for initial submittal, specification number and title, submittal category (for review or for information), description of item of work covered, and role and name of subcontractor.
 - 5. Account for time required for preparation, review, manufacturing, fabrication and delivery when establishing submittal delivery and review deadline dates.
 - a. For assemblies, equipment, systems comprised of multiple components and/or requiring detailed coordination with other work, allow for additional time to make corrections or revisions to initial submittals, and time for their review.

3.16 SUBMITTALS FOR REVIEW

- A When the following are specified in individual sections, submit them for review:
 - 1. Product data.
 - 2. Shop drawings.
 - 3. Samples for selection.
 - 4. Samples for verification.
- B Submit to Architect for review for the limited purpose of checking for compliance with information given and the design concept expressed in Contract Documents.
 - 1. Prepare clearly identified shop drawings or schedules to this specific project, containing only data applicable. Include with the shop drawings or schedules a letter of transmittal listing and dating the submitted drawings in sets.
 - 2. Contractor to review all submittals prior to submittal to Architect, and indicate such review with a stamp and signature. Review submittals for conformance to Drawings, Specifications, coordination with other trades and adjacent construction and verification of field dimensions. Failure of Contractor to adequately review submittals shall be cause for rejection.

- 3. Prepare and submit electronically (with exception for color charts and samples) to Architect for review, all shop drawings and manufacturers catalog sheets showing illustrated cuts of items to be furnished, scale details, sizes, dimensions, performance characteristics, capacities, wiring diagrams, weights and arrangements. Each submittal to include a transmittal on contractor letterhead. Submittal to be in the form of one combined PDF, labeled with project name, professionally assembled so all documents are facing the same way.
- C If equipment other than that used in the design of this project is proposed to be used, the Contractor and/or supplier shall verify electrical differences, dimension variations and weight increases. The Contractor shall be responsible for any extra costs incurred as a result of equipment substitutions.
- D Samples will be reviewed for aesthetic, color, or finish selection.
 - 1. Unless otherwise specified, submit samples of size, and nature representing typical qualities. Where required, submit a sufficient number of samples to demonstrate the complete range of variations of the material or quality. Written acceptance of the Architect is required prior to ordering any item for which samples are required.
- E After review, provide copies and distribute in accordance with SUBMITTAL PROCEDURES article below and for record documents purposes described in Section 01 78 00 Closeout Submittals.

3.17 SUBMITTALS FOR INFORMATION

- A When the following are specified in individual sections, submit them for information:
 - 1. Design data.
 - 2. Sustainability design submittals and reports.
 - 3. Certificates.
 - 4. Test reports.
 - 5. Inspection reports.
 - 6. Manufacturer's instructions.
 - 7. Manufacturer's field reports.
 - 8. Other types indicated.
- B Submit for Architect's knowledge as contract administrator or for Owner.

3.18 SUBMITTALS FOR PROJECT CLOSEOUT

- A Submit Correction Punch List for Substantial Completion.
- B Submit Final Correction Punch List for Substantial Completion.
- C When the following are specified in individual sections, submit them at project closeout in compliance with requirements of Section 01 78 00 Closeout Submittals:
 - 1. Project record documents.
 - 2. Operation and maintenance data.
 - 3. Warranties.
 - 4. Bonds.
 - 5. Other types as indicated.
- D Submit for Owner's benefit during and after project completion.

3.19 NUMBER OF COPIES OF SUBMITTALS

- A Electronic Documents: Submit one electronic copy in PDF format; an electronically-marked up file will be returned. Create PDFs at native size and right-side up; illegible files will be rejected.
- B Samples: Submit the number specified in individual specification sections; one of which will be retained by Architect.
 - 1. After review, produce duplicates.
 - 2. Retained samples will not be returned to Contractor unless specifically so stated.

3.20 SUBMITTAL PROCEDURES

- A General Requirements:
 - 1. Use a separate transmittal for each item.
 - 2. Submit separate packages of submittals for review and submittals for information, when included in the same specification section.
 - 3. Identify: Project; Contractor; subcontractor or supplier; pertinent drawing and detail number; and specification section number and article/paragraph, as appropriate on each copy.
 - a. When labeling shop drawings or product data, include the Specification Section number of where the product is specified for a submittal. For example, for cavity wall insulation Section 07 21 00 Insulation does not require an insulation submittal, but Section 04 20 00 Non-Bearing Masonry does require that submittal.
 - b. Identify "BacNet Review" on submittals requiring such review.
 - c. Identify "LEED" on submittals requiring such review.
 - 4. Apply Contractor's stamp, signed or initialed certifying that review, approval, verification of products required, field dimensions, adjacent construction work, and coordination of information is in accordance with the requirements of the work and Contract Documents.
 - a. Submittals from sources other than the Contractor, or without Contractor's stamp will be rejected.
 - 5. Deliver each submittal on date noted in submittal schedule, unless an earlier date has been agreed to by all affected parties, and is of the benefit to the project.
 - a. Deliver submittals to Architect via project management software.
 - b. Submit samples to Architect's office, securely packaged, with the name of the Owner and Project clearly indicated on the package exterior. Each physical sample shall have a label or tag, firmly attached to the sample, bearing the following information: (a) Name of Owner and Project, (b) Name of Supplier, (c) Name of Contractor, and (d) Product information such as manufacturer's designation, finish, type, class, grade, etc. as is appropriate. The Architect will retain one copy of each sample.
 - 6. Schedule submittals to expedite the Project, and coordinate submission of related items.
 - a. When submitting multiple submittals at the same time, provide the Architect with a priority list for review.
 - b. For each submittal for review, allow 15 days excluding delivery time to and from the Contractor.
 - c. For sequential reviews involving Architect's consultants, Owner, or another affected party, allow an additional 7 days.
 - d. For sequential reviews involving approval from authorities having jurisdiction (AHJ), in addition to Architect's approval, allow an additional 30 days.
 - 7. Identify variations from Contract Documents and product or system limitations that may be detrimental to successful performance of the completed work.
 - 8. When revised for resubmission, identify all changes made since previous submission.
 - 9. Incomplete submittals will not be reviewed, unless they are partial submittals for distinct portion(s) of the work, and have received prior approval for their use.
 - 10. Submittals not requested will not be recognized or processed.
- B Product Data Procedures:
 - 1. Submit only information required by individual specification sections.
 - 2. Collect required information into a single submittal.
 - 3. Submit concurrently with related shop drawing submittal.
 - 4. Do not submit (Material) Safety Data Sheets for materials or products.
 - 5. Submit sustainable design reporting submittals under separate cover.

- C Shop Drawing Procedures:
 - 1. Prepare accurate, drawn-to-scale, original shop drawing documentation by interpreting Contract Documents and coordinating related work.
 - 2. Do not reproduce Contract Documents to create shop drawings.
 - a. Contractor is to generate shop drawings based on the information identified in the contract documents and notify the architect of discrepancies in the documents.
 - 3. Generic, non-project-specific information submitted as shop drawings do not meet the requirements for shop drawings.
- D Samples Procedures:
 - 1. Transmit related items together as single package.
 - 2. Identify each item to allow review for applicability in relation to shop drawings showing installation locations.

3.21 SUBMITTAL REVIEW

- A The Architect will take one of the following actions on submittals:
 - 1. "Reviewed": Contractor shall proceed with ordering and/or fabrication.
 - 2. "Review Comments": Contractor shall proceed with ordering and/or fabrication after taking into account noted comments.
 - 3. "Rejected": Contractor shall provide a submittal that meets the intent of the specifications.
 - 4. "Revise and Resubmit": Contractor shall modify submittal to address comments and resubmit.
 - Submittals for Information: Architect will not acknowledge receipt, and take no other action.
- C Contractor to update the project management software to provide the action options listed above. "Approved" is not an acceptable action item and will not be used during the submittal review process.

3.22 BIM REQUIREMENTS AND SUBMITTALS

A General:

В

- 1. Refer to Specification Section 01 32 50 Building Information Model (BIM) and Provision of Electronic Submittal Data for additional project BIM requirements.
- 2. Provide a BIM model of the final construction with all equipment, materials and schedules populated in Owner provided BIM software.
- 3. After Bid award the Contractor shall be provided with the Contract Document BIM model.
- 4. The Contractor shall submit a resume for their proposed BIM Manager demonstrating their ability to manage and develop the model to a Level of Development (LOD) of minimum 400.
- B BIM Model Level of Development (LOD) applicable to the Work.
 - 1. After Bid award, a BIM Model LOD 300 will be provided to the Contractor.
 - 2. The Contractor will be required to interface with the Owner's Autodesk software (Revit, Tandem, etc.)
 - 3. The Contractor will be responsible for providing a final BIM Model LOD 350 at substantial completion. See Alternate #9 for providing a BIM Model LOD 400.
 - 4. The model elements shall be graphically represented within the model as a specific system, object, or assembly in terms of quantity, size, shape, orientation, and interfaces with other building systems. Non-graphic information may also be attached to the model elements. Equipment and material schedules shall not be included as a model element. Provide equipment and material schedules as an excel spreadsheet from a template provided by Owner.
 - 5. Contractor is responsible for providing the following building components:
 - a. Make and model numbers of all product data. Including, but not limited to all mechanical, electrical, low-voltage, and audio/visual equipment installed in the building, as well as all finish materials. *Refer to Specification Section 01 32 50 for additional lists/ requirements.*

- b. Hyperlinks of all product data and Operation and Maintenance manuals **liked** *linked* to each room as applicable for use and installation.
- c. Equipment, Finish Material, and Door Hardware schedules.
- d. BAS schedules.
- e. All Mechanical and Electrical equipment (e.g., starters) in the Mechanical/Sprinkler Rooms.
- f. All perimeter wall Work in the Mechanical/Sprinkler Rooms full height.
- g. All ceiling hung equipment Work in the Mechanical/Sprinkler Rooms.
- h. Mechanical and Electrical Work in main corridors including ceilings.
- i. Mechanical and Electrical Work located in the UFAD floor systems.
- j. All Electrical Work in the Electrical Rooms.
- k. All perimeter wall Work in the Electrical Rooms full height.
- 1. All ceiling hung equipment Work in the Electrical Rooms.
- m. All Mechanical and Electrical exterior service connections that are within a distance of 4 ft. in any direction of any exterior wall.
- n. All Mechanical and Electrical exterior service connections that are 4 ft. or a greater distance from any exterior wall.
- o. All remaining Architectural, Mechanical and Electrical Work not included above.
- p. All remaining exterior Work (Solar PV array, parking areas, landscaping).
- q. All roof Work.
- C Contractor shall appoint a BIM Manager who is responsible for the following:
 - 1. Overall responsibility for proper use, implementation, and creation of BIM during construction.
 - 2. Manage and maintain the creation of all BIM content.
 - 3. Coordinate and manage BIM related meetings with Owner BIM Technicians. Allow for a minimum of one on-site meeting per month, with supplemental virtual meeting as required to complete work.
 - 4. Work with Owner's IT department to ensure proper hardware and software is in place and functioning properly.
 - 5. Collect model information from all trades and input this information into the BIM model for the Work.
 - 6. Follow Owner provided naming conventions in a spreadsheet for all equipment, materials, and schedules added to the BIM model.
- D Record Documents: Provide an electronic copy of the final as-built version of the BIM model.
- E Training: Provide a minimum of 4 hours of training to Owner's staff.

END OF SECTION 01 30 00

SECTION 01 32 50

BUILDING INFORMATION MODEL (BIM) AND PROVISION OF ELECTRONIC SUBMITTAL DATA

PART 1 – GENERAL 1.01 DESCRIPTION

- A. Provide a BIM model of the Work using AutoCAD Revit software.
- B. Provide electronic Submittal data for the Work on spreadsheet provided by Owner.
- C. Refer to Specification Section 01 30 00 Administrative Requirements for BIM Manager qualification documentation requirements.

1.02 BIM MODEL REQUIREMENTS

- A. Building Information Modeling (BIM) is a digital collection of software applications designed to facilitate coordination and project collaboration. BIM can also be considered as a process for developing design and construction documentation by virtually constructing the building on the computer before actually building it.
- B. BIM Model Level of Development (LOD) definitions applicable to the Work.
 - 1. LOD 300: The Model Element is graphically represented within the Model as a specific system, object or assembly in terms of quantity, size, shape, location, and orientation. Non-graphic information may also be attached to the Model Element. Equipment schedules shall not be included as a Model Element. Provide Equipment Schedules as an Excel spreadsheet from a template provided by Owner.
 - 2. LOD 350: The Model Element is graphically represented within the Model as a specific system, object, or assembly in terms of quantity, size, shape, orientation, and interfaces with other building systems. This is the minimum level required for trade co-ordination during the construction process. Non-graphic information may also be attached to the Model Element. Equipment schedules shall not be included as a Model Element. Provide Equipment Schedules as an Excel spreadsheet from a template provided by Owner.
 - 3. After Bid award, the Contractor shall be provided with the Consultant's Revit model. This model is at LOD 300 (Architectural, Structural, Mechanical, and Electrical A/V, Low Voltage/ Security and Civil are represented in 2D).
 - 4. The Contractor is responsible for providing the following building components to the following Levels of Development.
 - a. All Mechanical and Electrical equipment (e.g., starters) in the Mechanical/Sprinkler Rooms LOD 350.
 - b. All perimeter wall Work in the Mechanical/Sprinkler Rooms full height LOD 350.
 - c. All ceiling hung equipment Work in the Mechanical/Sprinkler Rooms LOD 350.
 - d. Mechanical and Electrical Work in main corridors including ceilings LOD 350.
 - e. Mechanical and Electrical Work located in the UFAD floor systems LOD 350.
 - f. All Electrical Work in the Electrical Rooms LOD 350.
 - g. All perimeter wall Work in the Electrical Rooms full height LOD 350.
 - h. All ceiling hung equipment Work in the Electrical Rooms LOD 350.
 - i. All Mechanical and Electrical exterior service connections that are within a distance of 4 ft. in any direction of any exterior wall LOD 350.

- j. All Mechanical and Electrical exterior service connections that are 4 ft. or a greater distance from any exterior wall LOD 350.
- k. All remaining Architectural, Mechanical and Electrical Work not included above LOD 300.
- 1. All remaining exterior Work (Solar PV array, parking areas, landscaping) LOD 300.
- m. All roof Work LOD 300.
- 5. Show equipment schedules that have been approved by the Consultant via the project Submittal process in the Electronic Submittal spreadsheet templates provided or approved by Owner. Do not include this information in the BIM model.

1.03 QUALITY ASSURANCE

- A. The Contractor shall be responsible for providing a BIM model of the Work to the Level of Development defined in this section.
- B. The Contractor shall use BIM software that is approved by the Owner.
- C. The Contractor or shall appoint a BIM Manager who is responsible for the following:
 - 1. Take overall responsibility for the proper use, implementation, and creation of BIM during construction.
 - 2. Manage and maintain the creation of all BIM content.
 - 3. Coordinate and Manage BIM related meetings with lead BIM technicians. Allow for a minimum of one on-site meeting per month during the construction period. Host Teams/Zoom meetings as required for the Work.
 - 4. Work with Owner's IT department to ensure proper hardware and software is in place and functioning properly.
 - 5. Collect model information from all trades and input this information into the BIM model for the Work.
 - 6. Identify clashes and resolve clashes with the trades, the Consultants and the Owner.
 - 7. Collect and organize Electronic Submittal data from the trades for review by Consultants and Owner. Note that this data must not be incorporated into the BIM model.
 - 8 Owner will provide naming conventions in a spreadsheet for all equipment to be added to the BIM model.
 - 9. Provide an as-built version of the BIM model to Owner as part of the O&M package for the Work.
 - 10. Provide a minimum of 4 hours of training to Owner's staff.

1.04 SUBMITALS

- A. Submit the following items as outlined below:
 - 1. Design Review Report: The Report shall include the following:
 - a. Design alternatives proposed by Contractor to improve constructability.

- b. Virtual mockups that need to be built as working models or full scale mockups.
- c. Code validation issues.
- d. Owner-supplied naming conventions to be used.
- e. Owner-supplied asset tags to be used.
- f. Completed Element Attributes Table as described above.
- 2. Clash Detection Report: The Report shall provide a list of clashes to be resolved by the Consultant. Clash detection shall be performed on the following systems:
 - a. Architectural Systems vs. Structural Systems.
 - b. Architectural Systems vs. HVAC Systems.
 - c. Architectural Systems vs. Plumbing Systems.
 - d. Architectural Systems vs. Fire Protection Systems.
 - e. Architectural Systems vs. Electrical Systems.
 - f. Architectural Systems vs. Electronics Systems.
 - g. Structural Systems vs. HVAC Systems.
 - h. Structural Systems vs. Plumbing Systems.
 - i. Structural Systems vs. Fire Protection Systems.
 - j. Structural Systems vs. Electrical Systems.
 - k. Structural Systems vs. Electronics Systems.
 - 1. HVAC Systems vs. Plumbing Systems.
 - m. HVAC Systems vs. Fire Protection Systems.
 - n. HVAC Systems vs. Electrical Systems.
 - o. Interconnections between the Work of the Solar PV array Contractor and the Work of this General Contractor.
 - p. Clashes with any equipment in the Server Room and Radio Room.
- B. Provide the following Submittals required by these Specification Section as Excel spreadsheets. Pdf or scanned documents are not acceptable. Update to as-built conditions at the end of the Work.
 - 1. Provide make, model, serial number, product data sheet/shop drawing, O&M, and warranty data for the following specification sections:

07 42 13.23 Rainscreen Aluminum Composite Material Wall Panels

- 07 46 46 Fiber Reinforced Cementitious Panels
- 07 53 00 EPDM Membrane Roofing
- 07 54 23 Thermoplastic Membrane Roofing
- 07 61 00 Sheet Metal Roofing
- 11 13 19 Loading Dock Equipment
- 12 24 00 Window Shades
- 14 12 00 Electric Hoists
- 21 10 00 Water-Based Fire-Suppression Systems
- 21 22 00 Clean-Agent Fire Suppression Systems
- 21 31 13 Electric Drive, Centrifugal Fire Pumps Provide also Pump GPMs this specification
- 22 11 14 Domestic Water Packaged Booster Pumps Provide also:
 - Pump GPMs Electrical Data Plate Information
- 22 11 19 Domestic Water Piping Specialties Provide also certification this specification
- 22 11 23 Domestic Water Pumps Provide also:
 - Pump GPMs

Electrical Data Plate Information

- 22 33 00 Heat Pump Water Heaters
- 22 40 00 Plumbing Fixtures Provide also:
 - Finish/ Color
 - Provide all required information for the following fixture types:
 - Water closets
 - Urinals
 - Flush Valves
 - Shower Mixing Valve Assemblies
 - Lavatories
 - Faucets
 - **Drinking Fountains**
 - Eye/ Face Wash
 - Point of Use Mixing Valves
- 23 05 13 Common Motor Requirements for HVAC Equipment Provide also: Electrical Data Plate Information
- 23 09 00 Building Automation System
- 23 09 50 Variable Frequency Motor Controllers Provide also:
 - Electrical Data Plate Information
- 23 21 23 Hydronic Pumps Provide also: Pump GPMs
 - **Electrical Data Plate Information**
- 23 34 16 Air Handling Provide also:
 - Electrical Data Plate Information
- 23 36 00 Air Terminal Units Provide also: Electrical Data Plate Information
- 23 37 13 Diffusers, Registers, and Grilles Provide also finish/color this specification
- 23 37 23 HVAC Gravity Ventilators
- 23 52 21 Electric Boilers
- 23 64 30 Geothermal Water-to-Water Heat Pumps Provide also: Pump GPMs
 - **Electrical Data Plate Information**
- 23 73 13 Central-Station Air-Handling Units Provide also:
 - Electrical Data Plate Information
- 23 81 23 Computer-Room Air-Conditioners
- 23 82 19 Fan Coil Units
- 23 82 33 Heating Terminal Units
- 23 84 13 Humidifiers with Water Treatment System
- 26 05 36 Cable Trays for Electrical Systems Provide also finish/color this specification

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- 26 09 23 Lighting Control System
- 26 24 13 Switchboards
- 26 24 16 Panelboards
- 26 25 00 Enclosed Bus Assemblies
- 26 28 16 Enclosed Switches and Circuit Breakers
- 26 32 13 Engine Generators
- 26 33 53 Static Uninterruptible Power Supply Provide also: Electrical Data Plate Information
- 26 36 00 Transfer Switches
- 26 51 00 Lighting Provide also:
 - Electrical Information CCT (Correlated Color Temperature) CRI (Color-Rendering Index) LER (Luminaire Efficacy Rating) Lumens (Measured Output of Luminaire)
 - Foot Candles
 - Luminaires
 - LED Systems
 - Exit and Emergency Systems

28 13 00 Access Control

- 28 23 00 Video Surveillance
- 28 31 11 Fire Alarm Systems
- 2. Provide make/model, finish/color, fire rating, door schedule, shop drawings and warranty data for the following specification sections:
 - 08 11 13 Hollow Metal Doors and Frames
 - 08 14 16 Flush Wood Doors
 - 08 33 23 Overhead Coiling Doors Provide also O&M this specification
 - 08 44 13 Aluminum Storefront, Entrances and Curtainwalls
 - 08 56 56 Storm Shelter Windows and Doors
 - 08 71 00 Finish Hardware Provide also:

Type, style, function, size, label, hand, and finish of each door hardware item Manufacturer of each item Fastening and other connection information

Location of door hardware set, cross-referenced to Drawings, both on floor plans and in

- door/frame schedules
- Explanation of abbreviations, symbols, and codes
- Mounting locations for door hardware
- Door and frame sizes and materials
- Warranty information for each product
- 08 80 00 Glazing
- 09 51 00 Acoustical Ceilings
- 09 54 43 Stretched Fabric Ceiling
- 09 65 00 Resilient Flooring 09 68 13 Carpet Flooring
- 09 69 00 Access Flooring
- 09 84 30 Acoustical Panels
- 09 90 00 Painting and Coating
- 10 21 13.19 Plastic Toilet Partitions
- 10 44 00 Fire Protection Specialties

1.05 RECORD DOCUMENTS

- A. Provide an electronic copy of the final as-built version of the BIM model. Provide the model at the Levels of Development outlined in this Section.
- B. Provide electronic copies of the as-built electronic spreadsheet information.

PART 2 – PRODUCTS

Not Required

PART 3 – EXECUTION

Not Required

END OF SECTION 01 32 50

SECTION 21 10 00

WATER-BASED FIRE SUPPRESSION SYSTEMS

PART1: GENERAL

1.01 SUMMARY

- A. This Section is to include the following fire suppression systems inside the building.
 - 1. Wet-pipe sprinkler systems.
 - 2. Double interlock pre-action system.

B. Related Sections:

- 1. Section 25 20 21. 13.19 Integrated Automation BACnet Interface Device (Gateway/Native BACnet Devices) Double Action Pre-Action (All Types).
- 2. 25 20 21.31.13 Integrated Automation BACnet Interface Device (Gateways/Native BACnet Devices) Fire Pumps (All Types).
- 3. 25 00 13 Integrated Automation General Requirements All Trades Work Responsibilities.
- 4. Division 25 Schedule 3 BACnet Single Line Diagram and Responsibility Matrix (Applies to all Trades).

1.02 SYSTEM DESCRIPTIONS

- A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated and as required by NFPA and local authority having jurisdiction. The system shall include all piping, sprinklers, fittings, hangers, valves, flow switches, tamper switches, check valves, riser trim package(s), back-flow preventers, drains, inspector's test connections, fire department connections, gauges, signage and all other accessories and miscellaneous items required for a complete operating system even though each item is not specifically mentioned or described. The new sprinkler system shall be tested and ready for full operation prior to substantial completion of the project.
- B. Double Interlock Pre-Action System: A smoke detection event is required in addition to activation of the automatic sprinklers prior to water being allowed into the system piping. Refer to Specification Section 21 40 00 "Corrosion Management System" for pre-engineered nitrogen generator requirements. The double interlock pre-action system is initially filled with compressed nitrogen gas to mitigate the risk of corrosion.

1.03 PERFORMANCE REQUIREMENTS

- A. Standard piping System Component Working Pressure: Listed for at least 175 psig.
- B. Fire suppression sprinkler system design shall be approved by the authorities having jurisdiction.
 - 1. Margin of safety for available water flow and pressure: 5 psi, including losses through water-service piping, valves, and backflow preventers.
 - 2. Refer to drawings for sprinkler occupancy hazard classification.

1.04 DELEGATED DESIGN SERVICES

- A. The contractor shall provide design services to provide a system in accordance with the contract documents and referenced publications. Any conflicts between these documents shall be brought to the attention of the Engineer. The contractor is bidding the full scope of work in the drawings, specifications, and publications unless otherwise noted as an exclusion. The Owner shall not be charged additionally for work already contained within these contract documents. It remains the contractor's responsibility to read and understand the drawings, specifications, and referenced publications, and where questions persist, to resolve same before entering into the contract to perform this work. There shall be no extension of contract for work to be done as a part of this design package due to contractor's failure to implement the scope of work, plan the cost of such work, or the failure to verify field conditions.
- B. Automatic sprinkler system designs shall include hydraulic calculations for the required hazard occupancy (light, ordinary, extra) with uniform water distribution over the design area. Each system shall include materials, accessories, and equipment, inside and outside the building, so that the system is complete and ready for use. Design and provide each system to give full consideration to blind spaces, piping, electrical equipment, ducts and other construction and equipment in accordance with detailed working drawings to be submitted for approval. Design system to eliminate use of pressure reducing valves (PRVs) through use of increased pipe sizes, looped branch lines, and/or multiple risers.
- C. Contractor's designer shall be legally qualified to practice in jurisdiction where the project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that is similar in material, design, and extent to those indicated for this project.

1.05 SUBMITTALS

- A. Upon substantial completion of the system layout and hydraulic calculations, submit reproducible drawings and hydraulic calculations to the Engineer for review prior to completing the final shop drawing. The Engineer will review the system layout and return a print marked to show changes required before the final shop drawing is made.
- B. The final shop drawing shall be in accordance with the Authority Having Jurisdiction and shall include full size drawings of the complete piping and head layout indicating sprinkler zones, area hazard ratings, piping material, head types and method of hanging, hydraulic calculations must prove the remote area for each zone. Submit supplemental calculations for all non-typical areas.
- C. The final shop drawings must be stamped and signed by a Professional Engineer or individual with NICET level IV Certification.
- D. Upon completion of the final shop drawing, submit to the reviewing agencies for approval. The reviewing authorities may include the following:
 - 1. State Fire Marshal
 - 2. City/Local Fire Marshal
 - 3. Health and Building Department
- E. Submit final shop drawing to the Owner's insurance carrier.
- F. Submit final shop drawing to the Engineer in electronic format. The shop drawing shall be stamped "approved" by each of the reviewing agencies. "Approved" copies submitted shall include the agencies reviewer comments.
- G. Submit a statement certified by the design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

- H. Upon substantial completion of the project, submit contract closeout submittals to include two sets of as-builts drawings, operating and maintenance manuals, as-built hydraulic calculations, and "material and Test Certificates" for above and below ground piping. The drawings shall show the system as installed including all deviations from both the project drawings and the approved shop drawings. The drawings shall also include all information as required by NFPA 13.
- I. As-built hydraulic calculations must be submitted to prove remote area criteria is met with all included field modifications.
- J. Provide building maps showing areas of the building that are covered by the fire suppression systems installed. Maps shall be laminated and permanently attached to the wall in the riser room. For renovated systems, it is the responsibility of the contractor to update and/or replace the existing maps. Maps shall include the following information.
 - 1. Areas served by each sprinkler zone. The sprinkler zone names and numbers shall match labels on the riser zone pipes.
 - 2. Location of Fire Department Connection.
 - 3. Location of Riser Rooms.
 - 4. Location of Inspector's test connections.
 - 5. Location of Knox box.
- K. Include the BACnet Interface Device with Submittal showing proprietary points listed in 25 20 21.13.19 (PreAction Pumps) and 25 20 21.31.13 (Fire Pumps) are mapped to BACnet Object Types. Failure to do so will result in automatic rejection of the Submittal.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: Installation and alterations of fire protection piping, equipment, specialties, and accessories, and repair and servicing of equipment shall be performed only by a qualified installer. The term qualified means experienced in such work (experienced shall mean having a minimum of 5 previous projects similar in size and scope of this project), familiar with all precautions required, and has complied with all the requirements of the authority having jurisdiction. Upon request, submit evidence of such qualifications to the Architect.
- B. Qualifications for Welding Processes and Operators: Comply with the requirements of AWS D10.9,
 "Specifications for Qualifications of Welding Procedures and Welders for Piping and Tubing, Level AR-3."
- C. Regulatory Requirements: Comply with the requirements of the following codes:
 - 1. State Uniform Fire Code
 - 2. NFPA 13 Standard for the Installation of Sprinkler Systems.
 - 3. UL and FM Compliance: Fire protection system materials and components shall be Underwriter's Laboratories listed and labeled, and Factory Mutual approved for the application anticipated.
 - 4. International Building Code with State amendments.

1.07 COORDINATION

- A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.
- B. Do not interrupt sprinkler service to facilities occupied by Owner or others unless notifying the Owner, Construction Manager / General Contractor, Architect, and Engineer in advance and obtaining written approval.

1.08 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Sprinkler Cabinets: Finished, wall-mounting steel cabinet with hinged cover, with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler on Project.

PART 2: PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with requirements, manufacturers offering fire protection system products which may be incorporated in the work include the following:
 - 1. Listed Fire Protection Valves
 - a. Globe Fire Sprinkler Corp.
 - b. Milwaukee Valve Company
 - c. NIBCO
 - d. Mueller Company
 - e. Stockham
 - f. Victaulic Co. of America
 - g. Tyco
 - 2. Check Valves:
 - a. Crane Company
 - b. Globe Fire Sprinkler Corp.
 - c. Hammond Valve
 - d. Mueller Company
 - e. NIBCO
 - f. Potter-Roemer
 - g. Reliable Automatic Sprinkler Company
 - h. Stockham
 - i. Victaulic Company
 - j. Watts Industries
 - k. Tyco
 - 3. Grooved Mechanical Couplings:
 - a. Victaulic Company of America
 - b. Gruvlok
 - c. Tyco
 - 4. Fire Department Connection:
 - a. Elkhart Brass Manufacturing, Inc.
 - b. Potter Roemer
 - c. Reliable Automatic Sprinkler Company
 - d. United Brass Works, Inc.
 - 5. Sprinkler Heads:
 - a. Globe Fire Sprinkler Corp.

- b. Reliable Automatic Sprinkler Co., Inc.
- c. Viking Corp.
- d. Tyco
- 6. Fire Protection Specialties
 - a. ADT Security System, Inc.
 - b. ITT McDonnell and Miller
 - c. Potter Electrical Signal Co.
 - d. Viking Corp.
 - e. Watts Industries

2.02 PIPE AND TUBING MATERIALS

- A. General: Refer to Part 3 Article "PIPE APPLICATIONS" for identification of systems where the below specified pipe and fitting materials are used.
- B. Ductile Iron Pipe: AWWA C151
 - 1. Mechanical-Joint, Ductile-Iron Pipe: with mechanical-joint bell end and plain end.
 - a. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or grey-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - b. Glands, Gaskets, and Bolts: AWWA C111, ductile-or gray-iron gland, rubber gasket, and steel bolts and nuts.
 - 2. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell end and plain end.
 - a. Push-on-Joint, Ductile-Iron Fittings: [AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - b. Gaskets: AWWA C111, rubber.
 - 3. Grooved-End, Ductile-Iron Pipe: AWWA C151, with factory- or field-formed, radius-cut-grooved ends according to AWWA C606.
 - a. Grooved-End Fittings: ASTM A 536, ductile-iron casting with OD matching ductile-iron-pipe OD.
 - b. Grooved-End-Pipe Couplings: AWWA C606, gasketed fitting matching ductile-iron-pipe OD. Include ductile-iron housing with keys matching ductile-iron-pipe and fitting grooves, rubber gasket with center leg, and steel bolts and nuts.
 - c. Grooved-End-Pipe Transition Coupling: UL 213 and AWWA C606, gasketed fitting with endmatching ductile-iron pipe OD and end matching steel-pipe OD. Include ductile-iron housing with key matching ductile-iron-pipe groove and key matching steel-pipe groove rubber gasket listed for use with housing and steel bolts and nuts.
- C. Schedule 40 Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, hot-dip galvanized where indicated.
 - 1. Threaded-end, factory or field-formed.
 - a. Cast-Iron Threaded Flanges: ASME B16.1.
 - b. Malleable-Iron Threaded Fittings: ASME B16.3.
 - c. Gray-Iron Threaded Fittings: ASME B16.4.

- d. Steel Threaded Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, seamless steel pipe hot-dip galvanized where indicated. Include ends matching joining method.
- e. Steel Threaded Couplings: ASTM A 865 hot-dip galvanized-steel pipe where indicated.
- 2. Plain-end:
 - a. Steel Welding Fittings: ASTM A 234/A 234M, and ASM B16.9 or ASME B16.11.
 - b. Steel Flanges and Flanged Fittings: ASME B16.5.
- 3. Grooved-end, factory or field form square-cut or roll formed.
 - a. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
 - b. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pie OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, prelubricated rubber gasket listed for use with housing, and steel bolts and nuts.
- D. Threadable Thinwall Steel Pipe: ASTM A135 or ASTM A795, hot-dip galvanized where indicated.
 - 1. Threaded-end, factory or field-formed.
 - a. Cast-Iron Threaded Flanges: ASME B16.1.
 - b. Malleable-Iron Threaded Fittings: ASME B16.3.
 - c. Gray-Iron Threaded Fittings: ASME B16.4.
 - d. Steel Threaded Pipe Nipples: ASTM A 733, made of ASTM A 53/A 106, Schedule 40, seamless steel pipe hot-dip galvanized where indicated. Include ends matching joining method.
 - e. Steel Threaded Couplings: ASTM A 865 hot-dip galvanized-steel pipe where indicated.
 - 2. Plain-end.
 - a. Steel Welding Fittings: ASTM A 234/A 234M, and ASME B16.9 or ASME B16.11.
 - b. Steel Flanges and Flanged Fittings: ASME B16.5.
 - 3. Grooved-end, factory or field form square-cut or roll formed.
 - a. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
 - b. Grooved-End –Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, prelubricated rubber gasket listed for use with housing, and steel bolts and nuts.
- E. Schedule 10 Steel Pipe: ASTM A135 or ASTM 795 in NPS 5 and smaller, and NFPA 13-specified wall thickness in NPS 6 to NPS 10. Hot-dip galvanized where indicated.
 - 1. Plain-end.
 - a. Steel Welding Fittings: ASTM A 234/A 234M, and ASME B16.9 or ASME B16.11.
 - b. Steel Flanges and Flanged Fittings: ASME B16.5.
 - 2. Grooved-end, factory or field form square-cut or roll formed.
 - a. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
 - b. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting groves, prelubricated rubber gasket listed for use with housing, and steel bolts and nuts.

2.03 MECHANICAL OUTLET TEES

- A. Tee Housing: Ductile iron conforming to ASTM A536 grade 65-45-12 with enamel coating. Tee housing shall extend around the entire pipe circumference. U-bolts are not acceptable.
- B. Gaskets: Grade "E" EPDM for an operating temperature range -30°F to 230°F.
- C. Bolts/Nuts: Heat treated plated carbon steel conforming to ASTM A-449 and ASTM A-183.

2.04 LISTED FIRE-PROTECTION VALVES

- A. Valves shall be UL listed or FMG approved, with 175-psig minimum pressure rating. Valves shall have 250 psig pressure rating if valves are components of high-pressure piping system.
- B. Ball Valves: Comply with UL 1091, except with ball instead of disc.
 - 1. NPS 1-1/2 and Smaller: Bronze body with threaded ends.
 - 2. NPS 2 and NPS 2-1/2: Bronze body with threaded ends or ductile-iron body with grooved ends.
 - 3. NPS 3: Ductile-iron body with grooved ends.
- C. Butterfly Valves: UL 1091.
 - 1. NPS 2 and Smaller: Bronze body with threaded ends.
 - 2. NPS 2-1/2 and Larger: Bronze, cast-iron, or ductile-iron body; wafer type or with flanged or grooved ends.
- D. Check ValvesNPS 2 and Larger: UL 312, swing type, cast-iron body with flanged or grooved ends.
- E. Gate Valves: UL262, OS&Y type.
 - 1. NPS 2 and Smaller: Bronze body with threaded ends.
 - 2. NPS 2-1/2 and Larger: Cast-iron body with flanged ends.
- F. Indicating Valves: UL 1091, with integral indicating device and ends matching connection piping.
 - 1. Indicator: Visual.
 - 2. NPS 2 and Smaller: Ball or butterfly valve with bronze body and threaded ends.
 - 3. NPS 2-1/2 and Larger: Butterfly valve with cast- or ductile-iron body; wafer type or with flanged or grooved ends.

2.05 GENERAL-DUTY VALVES

- A. Ball Valves NPS 2 and Smaller: MSS SP-110, 2-piece copper-alloy body with chrome-plated brass ball, 600-psig minimum CWP rating, blowout-proof stem, and threaded ends.
- B. Check Valves NPS 2 and Smaller: MSS SP-80, Type 4, Class 125 minimum, swing type with bronze body, nonmetallic disc, and threaded ends.
- C. Gate Valves NPS 2 and Smaller: MSS SP-80, Type 2, Class 125 minimum, with bronze body, solid wedge, and threaded ends.
- D. Globe Valves NPS 2 and Smaller: MSS SP-80, Type 2, Class 125 minimum, with bronze body, nonmetallic disc, and threaded ends.

2.06 SPECIALTY VALVES

- A. Sprinkler System Control Valves: UL-listed or FMG approved cast- or ductile-iron body with flanged or grooved ends, and 175-psig minimum pressure rating Control valves shall have 250-psig pressure rating if valves are components of high-pressure piping system.
 - 1. Alarm Check Valves: UL 193, designed for horizontal or vertical installation, with bronze grooved seat with Oring seals, single-hinge pin, and latch design. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, and fill-line attachment with strainer.
 - a. Drip Cup Assembly: Pipe drain with check valve to main drain piping.
- B. Double Check Detector Assembly:
 - 1. The double check detector assembly consists of two independently operating, spring loaded check valves, two UL, FM, OSY resilient seated gate valves, and bypass assembly. The bypass assembly consists of a meter (cubic ft. or gallons), a double check including shutoff valves and required test cocks. Each cam-check shall be internally loaded and provide a positive drip tight closure against reverse flow. All internal parts shall be accessible through a single cover on the valve assembly. The bypass line shall be hydraulically sized to accurately measure low flow. The bypass line shall consist of a meter, a small diameter double check assembly with test cocks and isolation valves. The bypass line double check valve shall have two independently operating modular poppet check valves, and top mounted test cocks.
 - 2. Materials: All internal metal parts and main valve body: 300 Series stainless steel. Meter shall be bronze.
 - 3. Standards: ASSE 1048, AWWA C510-82, UL1469, FM.
 - 4. Rating: 175 PSI.

2.07 SPRINKLERS

- A. Sprinklers shall be UL listed or FMG approved, with 175-psig minimum pressure rating. Sprinklers shall have 250-psig pressure rating if sprinklers are components of high-pressure piping system.
- B. Automatic Sprinklers: With heat-responsive element complying with the following:
 - 1. UL 199, for nonresidential applications.
 - 2. UL 1767, for early-suppression, fast-response applications.
- C. Sprinkler Types and Categories: Nominal ¹/₂-inch orifice for "Ordinary" temperature classification rating, unless otherwise indicated or required by application.
- D. Sprinkler types, features, and options as follows: Provide quick response sprinklers.
 - 1. Concealed ceiling sprinklers, including cover plate.
 - 2. Pendent, dry-type sprinklers.
 - 3. Recessed sprinklers, including escutcheon.
 - 4. Sidewall sprinklers.
 - 5. Sidewall, dry-type sprinklers.
 - 6. Upright sprinklers.
- E. Sprinkler Finishes: Chrome plated, bronze, and painted.
- F. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
 - 1. Ceiling Mounting: Chrome-plated steel, one piece, flat.

- 2. Sidewall Mounting: Chrome-plated steel, one piece, flat.
- G. Sprinkler Guards: Wire-cage type, including fastening device for attaching to sprinkler. The sprinkler head and guard assembly shall be UL listed.

2.08 FIRE DEPARTMENT CONNECTIONS

- A. Wall-Type, Fire Department Connection: UL 405, 175-psig minimum pressure rating; with corrosion-resistant-metal body with brass inlets, brass wall escutcheon plate, brass lugged caps with gaskets and brass chains, and brass lugged swivel connections. Include inlets with threads according to NFPA 1963 and matching local fire department sizes and threads, outlet with pipe threads, extension pipe nipples, check devices or clappers for inlets, and escutcheon plate with marking similar to "AUTO SPKR & STANDPIPE."
 - 1. Type: Flush, with quantity of inlets required and square or rectangular escutcheon plate.
 - 2. Finish: Polished Brass.

2.09 ALARM DEVICES

- A. Alarm-device types shall match piping and equipment connections.
- B. Water-Flow Indicator: UL 346, electrical-supervision, paddle-operated-type, water-flow detector with 250-psig pressure rating and designed for horizontal or vertical installation. Include two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7A, 125-V ac and 0.25-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
- C. Pressure Switch: UL 753, electrical-supervision-type, water-flow switch with retard feature. Include single-pole, double-throw, normally closed contacts and design that operates on rising pressure and signals water flow.
- D. Valve Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled valve is in other than fully open position.
- E. Indicator-Post Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled indicator-post valve is in other than fully open position.

2.10 PRESSURE GAGES

- A. Description: UL 393, 3-1/2 to 4-1/2 inch diameter, dial pressure gage with range of 0 to 250 psig.
 - 1. Water System Piping: Including caption "WATER" or "AIR/WATER" on dial face.
 - 2. Air System Piping: Include caption "AIR" or "AIR/WATER" on dial face.

2.11 DOUBLE INTERLOCK PRE-ACTION SYSTEM

- A. FM approved components required for complete operational system including but not limited to pressure switches, tamper switches, and control valve. Smoke detection provided by Division 26. Provide with the following features:
 - 1. Main control valve with supervisory switch.
 - 2. Deluge valve.
 - 3. Diaphragm chamber control valve.
 - 4. Local manual control station.
 - 5. Water supply pressure gauge.
 - 6. Diaphragm pressure gauge.
 - 7. System drain valve.
 - 8. Diaphragm chamber automatic shut-off valve.
 - 9. Water motor alarm.
 - 10. Solenoid valve.
 - 11. Deluge release panel.

- 12. Supervisory air pressure gauge.
- 13. Nitrogen supply connections.
- 14. Low pressure alarm.
- B. Provide piping connection with isolation valve to the nitrogen generator system. Refer to Specification Section 21 40 00 "Corrosion Management System" for pre-engineered nitrogen generator system requirements.
- C. Alarm wiring back to fire alarm system annunciator panel will be by Division 28. Provide the following contacts for the alarm interface:
 - 1. Control valve tamper switch.
 - 2. Low pressure alarm switch.
 - 3. Water flow pressure switch.
 - 4. Deluge valve status.
- D. Provide, wire and program a UL listed control panel.

2.12 BACnet INTERFACE DEVICES

- A. Provide BACnet Interface Devices for each Double Interlock Pre-Action so that the units are presented as a series AV, BV and MSV BACnet objects. See 25 20 21.13.19 for the list of objects that must be supported. This list is the minimum acceptable.
- B. Provide BACnet Interface Devices for each Fire Pump so that the units are presented as a series AV, BV and MSV BACnet objects. See 25 20 21.31.13 for the list of objects that must be supported. This list is the minimum acceptable.

PART 3: EXECUTION

3.01 PREPARATION

- A. Perform fire-hydrant flow test according to NFPA 13, and NFPA 291. Use results for system design calculations required in Part 1 "Quality Assurance" Article. Flow test data shall include test date, residual hydrant location, flow hydrant location, static pressure at residual hydrant, measured flow at flow hydrant, and residual pressure at residual hydrant.
- B. Report test results promptly and in writing.
- C. Provide delegated design services in accordance with Part 1 of this specifications section.

3.02 EARTHWORK

A. Refer to Division 31 Section "Trenching, Backfilling, and Compacting" for excavating, trenching, and backfilling.

3.03 EXAMINATION

- A. Examine rough-in for fire equipment to verify actual locations of piping connections prior to installing.
- B. Do not proceed until unsatisfactory conditions have been corrected.

3.04 PIPE APPLICATIONS

- A. Underground Service Entrance Piping: Ductile-iron with push-on joint pipe and fittings and restrained joints.
- B. Service Entrance Piping: Ductile-Iron with mechanical joint pipe and fittings or grooved endpipe and fittings and restrained joints

- C. Standard-pressure, wet pipe and sprinkler system, 175 psig maximum working pressure.
 - 1. Non-corrosive areas with exposed piping subject to abuse or vandalism:
 - a. NPS 1 ¹/₂" and smaller: Schedule 40 with threaded, welded or grooved ends.
 - b. NPS 2" and larger: Schedule 10 with welded or grooved ends.
 - 2. Double interlock pre-action system:
 - a. NPS 1 ¹/₂" and smaller: Schedule 40 black steel with threaded, welded, or grooved ends.
 - b. NPS 2" and larger: Schedule 10 black steel with welded or grooved ends.
 - 3. All other supervised or concealed areas.
 - a. NPS 1 ¹/₂" and smaller: Threadable thin wall, with threaded, welded or grooved ends.
 - b. NPS 2" and larger: Schedule 10, with welded or grooved ends.

3.05 PIPE JOINTS

- A. Flanges, flanged fittings, unions, nipples, and transition and special fittings with finish and pressure ratings same as or higher than system's pressure rating may be used in above ground applications, unless otherwise indicated.
- B. Welded Joints: Provided welded joints where indicated on the drawings. Do not weld galvanized steel piping. Welding filler materials shall comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis.
- C. Flanged Joints: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- D. Threaded Joints: Comply with NFPA 13 for pipe thickness and threads. Do not thread pipe smaller than NPS 8 with wall thickness less than Schedule 40 unless approved by authorities having jurisdiction and threads are checked by a ring gage and comply with ASME B1.20.1.
- E. Grooved Joints: Assemble joints with listed coupling and gasket, lubricant, and bolts.
 - 1. Ductile-Iron Pipe: Radius-cut grooved ends of piping, use grooved-end fittings and grooved-end-pipe couplings.
 - 2. Steel Pipe: Square-cut or roll-groove piping as indicated. Use grooved-end fittings and rigid, grooved-end-pipe couplings, unless otherwise indicated.
 - 3. Copper Tube: Roll-groove tubing. Use grooved-end fittings and grooved-end-tube couplings.
- F. Dissimilar-Metal Piping Joints: Construct joints using dielectric fittings compatible with bolt piping materials.
 - 1. NPS 2 and Smaller: Use dielectric unions, couplings, or nipples.
 - 2. NPS 2 ¹/₂ to NPS 4: Use dielectric flanges.
 - 3. NPS 5 and Larger: Use dielectric flange insulation kit.
- G. Mechanical Outlet Tees: May be used only at connections to existing pipe mains with approval of each instance from the mechanical engineer. Connections to branch piping is not acceptable. Mechanical outlet tees shall:
 - 1. Tee housing: Divide iron conforming to ASTM A536 grade 65-45-12 with enamel coating. Tee housing shall extend around the entire pipe circumference. U-Bolts are not acceptable.

- 2. Gaskets: Grade "E" EPDM for an operating temperature range -30°F to 230°F.
- 3. Bolts/Nuts: Heat treated plated carbon sheet conforming to ASTM A-449 and ASTM A-183.

3.06 VALVE APPLICATIONS

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - 1. Listed Fire-Protection Valves: UL listed and FMG approved for applications where required by NFPA 13.
 - a. Shutoff Duty: Use ball, butterfly, or gate valves.
 - 2. Unlisted General-Duty Valves: For applications where UL-listed and FMG-approved valves are not required by NFPA 13.
 - a. Shutoff Duty: Use ball, butterfly, or gate valves.
 - b. Throttling Duty: Use ball or globe valves.

3.07 SERVICE-ENTRANCE PIPING

- A. Connect fire-suppression piping to water-service piping of size and in location indicated for service entrance to building. Refer to Division 22 Section "Domestic Water Piping" for exterior piping.
- B. Install shutoff valve, check valve, pressure gage, and drain at connection to water service.

3.08 PIPING INSTALLATION

- A. Refer to Division 21 Section "Common Work Results for Fire Suppression" for basic piping installation.
- B. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
 - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
- C. Install underground ductile-iron service-entrance piping according to NFPA 24 and with restrained joints.
- D. Install underground copper service-entrance piping according to NFPA 24.
- E. Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- F. Install unions adjacent to each valve in pipes NPS 2 and smaller. Unions are not required on flanged devices or in piping installations using grooved joints.
- G. Install flanges or flange adapters on valves, apparatus, and equipment having NPS 2-1/2 and larger connections.
- H. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, sized and located according to NFPA 13.
- I. Install sprinkler piping with drains for complete system drainage.
- J. Install sprinkler zone control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- K. Install ball drip valves to drain piping between fire department connections and check valves. Drain to floor drain or outside building.

- L. Install alarm devices in piping systems.
- M. Hangers and Supports: Comply with NFPA 13 for hanger materials.
 - 1. Install sprinkler system piping according to NFPA 13.
- N. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft metal seated glob valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.
- O. Fill wet-pipe sprinkler system piping with water.

3.09 VALVE INSTALLATION

- A. Installed listed fire-protection valves, unlisted general-duty valves, specialty valves and trim, controls, and specialties according to NFPA and authorities having jurisdiction.
- B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Valves for Wall-Type Fire Hydrants: Install nonrising-stem gate valve in water-supply pipe.
- D. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potablewater supply sources.
- E. Specialty Valves:
 - 1. Double Detector Check Valves: Install for proper direction of flow, including bypass check valve and retarding chamber drain-line connection.

3.10 SPRINKLER APPLICATIONS

- A. Drawings indicate sprinkler types to be used. Where specific types are not indicated, use the following sprinkler types:
 - 1. Rooms without Ceilings: Upright sprinklers.
 - 2. Rooms with Suspended Ceilings: Recessed sprinklers. Provide concealed sprinklers where ceiling heights are less than 7'-8" and where indicated on the Drawings.
 - 3. Wall Mounting: Sidewall sprinklers.
 - 4. Spaces Subject to Freezing: Pendent, dry sprinklers or sidewall, dry sprinklers.
 - 5. Gymnasium Soffit: Concealed sprinklers.
 - 6. Sprinkler Finishes:
 - a. Upright, Pendent, and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view, rough bronze in unfinished spaces not exposed to view, wax coated where exposed to acids, chemicals or other corrosive fumes.
 - b. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
 - c. Flush Sprinklers: Bright chrome, with painted white escutcheon.
 - d. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.

B. Provide sprinkler guards at all heads installed exposed in gyms and other similar spaces and when installed at heights 7'-0" or less and where indicated on the drawings.

3.11 SPRINKLER INSTALLATION

- A. For suspended acoustical ceiling systems, align sprinklers as follows:
 - 1. 2'x4' Ceiling Grid: Within 2" of the center or quarter points of the acoustical ceiling tile.
 - 2. 2'x2' Ceiling Grid: Within 2" of the center of the acoustical ceiling tile.
- B. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing. Use dry-type sprinklers with water supply from heated space.

3.12 HOSE CONNECTION INSTALLATION

- A. Install hose connections adjacent to standpipes, unless otherwise indicated.
- B. Install freestanding hose connections for access and minimum passage restriction.
- C. Install NPS 2-1/2 hose connections with quick-disconnect at NPS 2-1/2 by NPS 1-1/2 reducer adapter and flow-restricting device, unless otherwise indicated.

3.13 FIRE DEPARTMENT CONNECTION INSTALLATION

- A. Install wall-type, fire department connections in vertical wall.
- B. Install ball drip valve at each check valve for fire department connection.
- C. Route ball drip to nearest floor drain or provide full size through exterior wall. Terminate exterior drain with a 45 degree elbow down and provide a galvanized wall escutcheon.

3.14 INSTALLATION OF ALL BACnet INTERFACE DEVICES

- A. See the Division 25 Responsibility Matrix for the execution responsibilities for Equipment Supplier, Controls and Electrical Subcontractor. The Equipment Supplier is responsible for supplying and installing the BACnet Interface Device. Electrical is responsible for power and any control wiring if the device does not have a single point of connection.
- **B.** The BACnet Interface Device are all BACnet/IP devices. See Division 25 for networking responsibilities for each BACnet Interface Device.
- C. Division 25 is responsible for communicating with the BACnet Interface Device using BACnet objects and services to access this data and for mapping the BACnet objects from the device(s) in this Specification Section to the BACnet Object Integration Device to create graphics, reports, trends, alarms, schedules and other requirements specified in Division 25. Division 25 is only responsible for communicating with the BACnet Interface Device using BACnet objects and services to access this data.
- D. This BACnet Interface Device is a BACnet/IP device. See Division 27 for networking responsibilities.

3.15 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.

- C. Connect water-supply piping to fire-suppression piping. Include backflow preventer between potable-water piping and fire-suppression piping. Refer to Division 22 Section "Domestic Water Piping Specialties" for backflow preventers
- D. Install ball drip valves at each check valve for fire department connection. Drain to floor drain or outside building.
- E. Connect piping to specialty valves, hose valves, specialties, fire department connections, and accessories.
- F. Electrical Connections: Power wiring is specified in Division 26. Fire alarm connections are specified in Division 28.
- G. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- H. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.16 LABELING AND IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA.

3.17 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment
 - 3. Energize circuits to electrical equipment and devices.
 - 4. Start and run excess pressure pumps.
 - 5. Start and run air compressors.
 - 6. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
 - 7. Coordinate with fire alarm tests. Operate as required.
 - 8. Verify that equipment hose threads are same as local fire department equipment.
- B. Report test results promptly and in writing to Architect and authorities having jurisdiction.

3.18 CLEANING AND PROTECTION

- A. Clean dirt and debris from sprinklers.
- B. Remove and replace sprinklers with paint other than factory finish.
- C. Protect sprinklers from damage until Substantial Completion.

3.19 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate and maintain the water-based fire suppression system. Refer to Division 01 Section "Demonstration and Training."
 - 1. Required Time: As required.
- B. Refer to Division 25 08 00, 25 08 01 and 25 20 21.13.19, and 25 20 21.31.13 for additional start-up, commissioning and training requirements for the BACnet Interface Devices provided in this Specification Section

END OF SECTION 21 10 00

SECTION 21 22 00

CLEAN AGENT FIRE SUPPRESSION SYSTEM

PART 1: GENERAL

1.01 SUMMARY

- A. This Section specifies 3M NOVEC clean agent suppression systems for areas as noted on the drawings. Materials and equipment specified in this Section include:
 - 1. Storage and distribution
 - 2. Control panel
 - 3. Detectors
- B. Related Sections:
 - 1. Section 25 20 21.22.00 Integrated Automation BACnet Interface Device (Gateway/Native BACnet Devices) Clean Agent Fire Suppression Systems (All Types).
 - 2. Section 25 20 21.22.01 Integrated Automation BACnet Interface Device (Gateway/Native BACnet Devices) VESDA Detection Systems (All Types).
 - 3. 25 00 13 Integrated Automation General Requirements All Trades Work Responsibilities.
 - 4. Division 25 Schedule 3 BACnet Single Line Diagram and Responsibility Matrix (Applies to all Trades).
- C. Provide the following electrical work as work of this section, complying with all Division 16 requirements.
 - 1. Control wiring between field installed controls, indicating devices, and control panels.
- D. Items provided by others:
 - 1. 110VAC/1PH/10A dedicated, source panel grounded power circuit to Special Agent System control panel(s) and auxiliary power supplies, where applicable.
 - 2. Interface wiring with Fire Alarm System, per the listed interface point schedule, in this specification section.
 - 3. Interface wiring with HVAC system shutdown, with Clean Agent system discharge pressure switch.
 - 4. Seal of protected space(s), to prevent agent leakage after discharge. This includes lay-in ceiling tile hold-down clips eight feet (8') around each agent discharge nozzle.
 - 5. Fire dampers, 110VAC energized open/ fail close motorized operators and interface wiring with the Clean Agent system discharge pressure switch.
 - 6. Double-interlock preaction fire sprinkler system.

1.02 APPLICABLE STANDARDS AND PUBLICATIONS

- A. The design, installation, testing and maintenance of 3M NOVEC Clean Agent Suppression/ Double Interlock Preaction Sprinkler Releasing Systems shall be in accordance with the requirements set forth in the current editions of the following codes and standards. The standards listed, as well as all other applicable codes, standards, and good engineering practices, shall be used as "minimum" design standards. No other agent shall be considered.
 - 1. NFPA 2001: Standard on Clean Agent Fire Extinguishing Systems—2004 Addition

- 2. NFPA 72 : National Fire Alarm Code---2002 Addition
- 3. Factory Mutual Approval Guide.
- 4. Requirements of the Authority Having Jurisdiction (AHJ).

1.03 QUALITY ASSURANCE

- A. Hardware Manufacturer
 - 1. The manufacturer of the suppression system hardware shall be an original equipment manufacturer. All components shall be UL listed and FM approved as a compatible component of a system.
 - 2. The manufacturer of the suppression system hardware and detection components shall be ISO 9000 registered and meet requirements of ISO 14520.1 and relevant national standards.
 - 3. The name of the manufacturer shall appear on all major components.
 - 4. All devices, components and equipment shall be the products of the same manufacturer.
 - 5. All devices and equipment employed shall be Underwriters Laboratories (UL) listed and/or Factory Mutual (FM) approved and compliant with the requirements of ISO 14520.1 and the relevant National Standards.
- B. Qualifications
 - 1. The installing contractor shall be trained by the suppression systems hardware supplier to design, install, test and maintain 3M NOVEC fire suppression systems.
 - 2. The design/ installation contractor shall employ a designer with a minimum certification of NICET Level III, Special Hazards.
 - 3. The installing contractor shall provide 24/7 emergency service and shall have an inventory of bulk 3M NOVEC for recharge purposes. Physical proof of inventory is required if requested. Emergency on-site response shall be within two (2) hours of receipt of call.
 - 4. The installing contractor shall provide experience in the installation of 3M NOVEC systems. A list containing ten (10) completed projects shall be provided to the engineer before the start of design engineering.

1.04 SUBMITTALS

- A. The shop drawing submittal shall be in accordance with the IBC and UFC and shall include the following:
 - 1. Installation layout drawings detailing the quantity, location, and marking of all system components, including, but not limited to, agent storage tanks, nozzles, pipe runs including pipe sizes and lengths, control panel(s), detectors, manual pull stations, abort stations, audible and visual alarms.
 - 2. Separate layouts, or drawings, shall be provided for each level, (i.e., room, under floor, and above ceiling) and for mechanical and electrical work.
 - 3. Electrical layout drawings shall show the location of all devices and include point-to-point conduit runs and a description of the method(s) used for detection mounting.
 - 4. Hydraulic flow calculations, from a UL listed computer program, shall be provided for all engineered 3M NOVEC suppression systems. Calculation sheet(s) must include the manufacturers name and UL listing number for verification. The flow calculations shall detail pressure changes, flow rates, pipe sizes and lengths, and nozzle sizes. The agent discharge time must be shown and detailed by zone.

- 5. A complete sequence of operation shall be submitted detailing all alarm devices, shutdown functions, remote signaling, damper operation, time delay and agent discharge for each zone or system.
- 6. Information outlining the operation and maintenance procedures required of the system Owner.
- Include the BACnet Interface Device with Submittal showing proprietary points listed in 25 20 21.22.00 (Clean Agent Suppression) and 25 20 21.22.01 (VESDA Detection) are mapped to BACnet Object Types. Failure to do so will result in automatic rejection of the Submittal.

PART 2: PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with requirements, provide a 3M NOVEC clean agent suppression system as manufactured by one of the following.
 - 1. The Ansul Company
 - 2. Fenwal Protection Systems
 - 3. Kidde Fire Systems

2.02 SYSTEM DESCRIPTION

- A. The system shall provide a 3M NOVEC agent minimum design concentration of 4.5% by volume for Class A hazards and a manufacturers recommended concentration for Class B hazards, in all protected spaces, at the minimum anticipated temperature, within the protected area. This project shall be designed at 5% 3M NOVEC concentration (.0455), because the equipment power will not shutdown upon agent discharge. Time delays shall be provided to allow for occupant egress. Systems shall be designed to include a maintenance lockout switch that breaks the signal circuit to the electric actuator(s).
- B. The system discharge time shall not exceed 10 seconds in accordance with ISO 14520.1.
- C. The 3M NOVEC suppression system shall include a detection and control system with provision for both prealarm, automatic and manual agent release.
- D. The system shall be actuated by VESDA high sensitivity air sampling detection. Detectors utilizing water shall not be allowed. The detection system shall employ multi-obscuration level, cross-zoned detection. In the case of cross-zone detection, the first lower level of programmed sensitivity shall cause an alarm signal to be generated; a second higher level of programmed sensitivity activation shall generate a pre-discharge signal and start the pre-discharge condition.
- E. 3M NOVEC shall be stored in central storage steel containers compliant with the requirements of ISO 14520.1 and the relevant National Standards. The storage containers shall be equipped with safety rupture disks and each container shall have a pressure gauge to provide visual supervision of the container pressure. Wall or ceiling mounted cylinders shall not be allowed.

2.03 BACnet INTERFACE DEVICES

- A. Provide BACnet Interface Devices for each Clean Agent Fire Suppression System so that the units are presented as a series of AV, BV and MSV BACnet objects. See 25 20 21.22.00 for the list of objects that must be supported. This list is the minimum acceptable.
- B. Provide BACnet Interface Devices for each VESDA Fire Detection System so that the units are presented as a series of AV, BV and MSV BACnet objects. See 25 20 21.22.01 for the list of objects that must be supported. This list is the minimum acceptable.

2.04 AGENT STORAGE AND DISTRIBUTION

- A. 3M NOVEC shall be stored in central storage steel alloy containers, compliant with the requirements of ISO 14520.1 and the relevant National Standards, and equipped with safety rupture disks. Containers shall be super-pressurized with dry nitrogen to an operating pressure of 25 bar at 21°C, or to an operating pressure of 42 bar at 21°C.
- B. Each system shall have its own supply of clean agent
- C. Each supply shall be located within the hazard area, or as near as possible, to reduce the amount of pipe and fittings required to install the system.
- D. Engineered discharge nozzles shall be provided within the manufacturer's guidelines to distribute the 3M NOVEC agent throughout the protected spaces. The nozzles shall be designed to provide proper agent quantity and distribution and shall be UL listed and/or FM approved, and shall comply with the requirements of ISO 14520.1 and the relevant National Standards. Nozzle spacing shall be in accordance with the UL listing and/or FM approval, and in accordance with the requirements of ISO 14520.1 and the relevant National Standards.
- E. Distribution piping and fittings shall be installed in accordance with the manufacturer's requirements, ISO 14520.1, the relevant National Standards, and approved piping standards and guidelines. Qualified individuals using accepted practices and quality procedures shall install all distribution piping. All piping shall be adequately supported and anchored at all directional changes and nozzle locations. Chrome escutcheons shall be installed on piping at all exposed penetrations in finished areas.
- F. All piping shall be thoroughly reamed after cutting, and all oil and/or chips shall be removed. Pipe threads shall be coated with Teflon tape or an appropriate joint compound applied to the male thread only.
- G. All agent containers shall be activated by an electric manual discharge station, an automatic device or devices, or by direct mechanical actuation. Electric re-settable solenoid actuators shall be utilized, expendable single-use actuators and cylinder actuation rupture discs shall not be allowed.

2.05 FIRE SUPPRESSION CONTROL PANEL (FSCP)

- A. The analog addressable FSCP and its components shall be UL listed and/or FM approved for release of 3M NOVEC and double interlock preaction sprinkler systems, and shall conform to the specifications of the control panel manufacturer, and to the requirements ISO 14520.1 and the relevant National Standards. One FSCP shall be provided for each protected zone.
- B. The FSCP shall be programmable such that an adequate pre-discharge alarm period can be set.
- C. The FSCP shall perform all functions necessary to operate the system detection, actuation and auxiliary alarm.
- D. The FSCP shall include battery standby power to support 24 hours in standby and 5 minutes in alarm.
- E. The FSCP shall be capable of supporting cross-zone detection.
- F. Provide the following dry contacts for the fire alarm interface:
 - 1. General system trouble--FSCP
 - 2. General system supervisory--FSCP
 - 3. General system alarm—FSCP
 - 4. System discharge (each discharge zone)--Discharge Pressure Switch
- G. The FSCP shall individually monitor the double interlock preaction sprinkler flow, tamper and low-air switches as separate addressable initiation points.

2.06 DETECTORS

- A. The detectors shall be spaced and installed in accordance with the manufacturer's specifications, and the requirements of ISO 14520.1 and the relevant National Standards.
 - 1. The detection system shall employ addressable cross-zoned air sampling high sensitivity smoke detection, as specified by the hardware manufacturer and the appropriate authority having jurisdiction.
 - 2. In the case of cross-zone detection, a first level smoke obscuration shall cause an alarm signal to be generated; a second level of smoke obscuration shall generate a pre-discharge signal and start the pre-discharge condition.

2.07 MANUAL RELEASE

- A. Provision shall be made for manual operation of the system from outside the protected space or adjacent to the main exit from the space.
- B. The addressable manual release switch or manual pull station shall be a dual action device requiring two distinct operations to initiate a system actuation.

2.08 ABORT STATIONS

- A. The addressable abort switches shall be within the protected area and shall be located near the means of egress for the area.
- B. Operation of the abort station shall send a "system aborted" indication to the control panel when a fire condition exists. A "trouble" indication shall result if the abort station is operated when no alarm condition exists. The abort station shall re-start the 30-second time delay sequence.

2.09 MAINTENANCE BYPASS SWITCH

A. The maintenance bypass switch shall be installed at the FSCP. This switch shall break the low-voltage circuit(s), preventing a release signal from reaching the 3M NOVEC solenoid valve(s). The FSCP shall show a trouble condition while the system is in the bypass mode.

2.10 AUDIBLE AND VISUAL ALARMS

- A. Electrically actuated fire alarms, both audible and visible, shall be furnished and installed. All alarm devices shall be UL listed and/or FM approved and compliant with the requirements of ISO 14520.1 and the relevant National Standard.
- B. Alarms shall be adequate to alert personnel located in the protected areas.
- C. A discharge strobe device shall be placed outside, and above, each exit door from the protected space. Provide an advisory sign at each location.

2.11 CAUTION AND ADVISORY SIGNS

- A. Caution and advisory signs are required inside and outside of each entrance to a protected space (s), and at each manual discharge station.
- B. A flashing light sign is required over each exit from a protected space.

2.12 SYSTEM AND CONTROL WIRING

A. All low-voltage systems wiring shall be furnished and installed by the contractor.

- B. All wiring shall be installed by qualified individuals to conform to the requirements of the ISO 14520.1 and the relevant National Standards.
- C. The complete system electrical installation, and all auxiliary components, shall be connected to earth ground in accordance with the ISO 14520.1 and the relevant National Standard.
- D. All wiring shall be in conduit or raceway. Exposed wiring shall be in conduit.

PART 3: EXECUTION

3.01 SEQUENCE OF OPERATION

- A. Cross-zone detection, control as follows:
 - 1. Actuation of the first level of smoke obscuration (.08%) shall:
 - a. Illuminate an "ALARM" indicator on control panel face.
 - b. Energize an alarm bell or energize flashing strobe and sound horn (slow pulsed tone).
 - c. Send an alarm signal to the building Fire Alarm.
 - d. Close all doors leading into the protected area.
 - 2. Actuation of the second level of smoke obscuration (3.0%) shall:
 - a. Illuminate a "PREDISCHARGE" indicator on control panel face.
 - b. Energize alarm strobe and sound horn (rapid pulsed tone).
 - c. Close all doors leading into the protected area.
 - d. Actuate a time delay sequence and enable the system abort sequence.
 - 3. Expiration of the 30-second time delay shall:
 - a. The 3M NOVEC release solenoid shall be energized, discharging the system.
 - b. The 3PDT agent discharge pressure switch shall be operated.
 - c. The double-interlock preaction sprinkler release solenoid shall be energized, causing phase one of the
 - d. two water release sequence phases to be satisfied.
 - 4. Activation of the 3PDT Agent Discharge Pressure Switch shall:
 - a. Cause shutdown of the HVAC system.
 - b. Signal the motorized fire damper(s) to close.
 - c. Send a 3M NOVEC discharge signal to the building Fire Alarm System.

3.02 INSTALLATION OF BACnet INTERFACE DEVICES

- A. See the Division 25 Responsibility Matrix for the execution responsibilities for Equipment Supplier, Controls and Electrical Subcontractor. The Equipment Supplier is responsible for supplying and installing the BACnet Interface Device. Electrical is responsible for power and any control wiring if the device does not have a single point of connection.
- B. The BACnet Interface Device are all BACnet/IP devices. See Division 25 for networking responsibilities for each BACnet Interface Device.
- C. "Division 25 is responsible for communicating with the BACnet Interface Device using BACnet objects and services to access this data and for mapping the BACnet objects from the device(s) in this Specification Section to the BACnet Object Integration Device to create graphics, reports, trends, alarms, schedules and other requirements specified in Division 25." Division 25 is only responsible for communicating with the BACnet Interface Device using BACnet objects and services to access this data.
- D. This BACnet Interface Device is a BACnet/IP device. See Division 27 for networking responsibilities.

3.03 SYSTEM INSPECTION AND CHECKOUT

- A. The final test and acceptance shall be conducted in the presence of the system Owner's representative and governing authorities, and shall be conducted in accordance with the requirements of ISO 14520.1 and the relevant National Standards.
 - 1. Tests shall demonstrate that the entire control system functions as intended. Automatic discharge, manual discharge, equipment shutdown, and alarm devices shall be tested.
 - 2. All containers and distribution piping shall be checked for proper mounting and installation.
 - 3. All electrical wiring shall be tested for proper connection, continuity and resistance to earth.
 - 4. Room integrity tests shall be conducted in accordance with ISO 14520.1, Annex E, and the relevant National Standards.
 - 5. An inspection shall be made to ensure that all required dampers, door bottom seals, weather-stripping, caulking and foam sealant have been installed and that the areas protected shall contain the 3M NOVEC.
 - 6. All piping shall be pneumatically tested in a closed circuit for a period of 10 minutes at 3 bar; at the end of 10 minutes, the pressure drop shall not exceed 20 percent of the test pressure.
 - 7. A flow test employing nitrogen shall be performed on the piping network to verify that flow is unobstructed through the piping and nozzles.
 - 8. Fire Alarm system interface tests. Coordinate testing procedures with the fire alarm contractor.
 - 9. Refer to 25 08 01, 25 08 02, 25 20 21.22.01 and 25 20 21.22.00 for start-up and commissioning requirements for the BACnet Interface Devices provided in this Specification Section.

3.04 DEMONSTRATION

- A. Prior to final acceptance, the installing contractor shall provide operational training to each shift of the Owner's maintenance personnel. The training shall address emergency procedures, abort functions, system control panel operation, troubleshooting procedures and safety requirements. Refer to Division 01 Section "Demonstration and Training."
 - 1. Required Time: 4 hours.
- B. Refer to 25 08 00, 25 08 01, 25 20 21.22.00, and 25 20 21.22.01 for training requirements for the BACnet Interface Devices provided in this Specification Section.

3.05 OPERATION AND MAINTENANCE

A. Prior to final acceptance, the installing contractor shall provide operation and maintenance instruction manuals to the system Owner. Checklists and procedures for emergency situations, troubleshooting techniques, maintenance operations and procedures shall be included in the manual.

3.06 AS-BUILT DRAWINGS

A. Upon completion of each system, the installing contractor shall provide copies of the system "As-Built" drawings to the Owner.

3.07 SYSTEM INSPECTIONS

A. The installing contractor shall provide two inspections, of each system installed under this contract, during the system hardware manufacturer's warranty period. Inspections shall be conducted in accordance with recommendations of ISO 14520.1 and the relevant National Standards.

END OF SECTION 21 22 00

SECTION 21 31 13

ELECTRIC-DRIVE, CENTRIFUGAL FIRE PUMPS

PART 1: GENERAL

1.01 SUMMARY

- A. This Section includes electric-drive, split-case, in-line centrifugal fire pumps and the following:
 - 1. Full-service fire-pump controllers and automatic transfer switches.
 - 2. Fire-pump accessories and specialties.
 - 3. Pressure-maintenance pumps, controllers, accessories, and specialties.
 - 4. Alarm panels.
 - 5. Flowmeter systems.

B. Related Sections:

- 1. 25 20 21.31.13 Integrated Automation BACnet Interface Device (Gateway/Native BACnet Devices) Centrifugal Fire Pumps (All Types).
- 2. Section 25 00 13 Integrated Automation General Requirements All Trades Work Responsibilities.
- 3. Division 25 Schedule 3 BACnet Single Line Diagram and Responsibility Matrix (Applies to all Trades).

1.02 PERFORMANCE REQUIREMENTS

A. Pump, Equipment, Accessory, Specialty, and Piping Pressure Rating: 175-psig minimum working-pressure rating, unless otherwise indicated.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, certified pump performance curves with each selection point indicated, operating characteristics, and furnished accessories and specialties for each fire pump and pressure-maintenance pump.
- B. Shop Drawings: For fire pumps and drivers, fire-pump controllers, fire-pump accessories and specialties, pressuremaintenance pumps, pressure-maintenance-pump controllers, and pressure-maintenance-pump accessories and specialties. Include plans, elevations, sections, details, and attachments to other work.
 - 1. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 2. Wiring Diagrams: Power, signal, and control wiring.
- C. Product Certificates: For each type of fire pump and fire-pump controller, signed by product manufacturer.
- D. Source quality-control test reports.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For fire pumps and drivers, pressure-maintenance pumps, controllers, accessories and specialties, alarm panels, and flowmeter systems to include in emergency, operation, and maintenance manuals.

G. Include the BACnet Interface Device with Submittal showing proprietary points listed in 25 20 21.31.13 are mapped to BACnet Object Types. Failure to do so will result in automatic rejection of the Submittal.

1.04 QUALITY ASSURANCE

- A. Source Limitations: Obtain fire pumps, pressure-maintenance pumps, and controllers through one source from a single manufacturer for each type of equipment.
- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of fire pumps, pressuremaintenance pumps, and controllers and are based on specific systems indicated. Refer to Division 01 Section "Product Requirements."
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with standards of authorities having jurisdiction pertaining to materials, hose threads, and installation.
- E. Comply with NFPA 20, "Stationary Pumps for Fire Protection," for fire pumps, drivers, controllers, accessories, and their installation.

1.05 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

PART 2: PRODUCTS

2.01 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 CENTRIFUGAL FIRE PUMPS

- A. Description, General: UL 448, factory-assembled and -tested, electric-drive, centrifugal fire pumps capable of furnishing not less than 150 percent of rated capacity at not less than 65 percent of total rated head and with shutoff head limited to 140 percent of total rated head.
 - 1. Finish: Manufacturer's standard red paint applied to factory-assembled and -tested unit before shipping.
 - 2. Nameplate: Complete with capacities, characteristics, and other pertinent data.
- B. Fabricate base and attachment to fire pumps, pressure-maintenance pumps, and controllers with reinforcement to resist movement of pumps and controllers during a seismic event when their bases are anchored to building structure.
- C. In-Line Fire Pumps: Vertically mounted type with electric-motor driver directly mounted to pump casing.

- 1. Manufacturers:
 - a. A-C Pump; ITT Industries.
 - b. Armstrong Darling, Inc.
 - c. Aurora Pump; Pentair Pump Group.
 - d. Fairbanks Morse; Pentair Pump Group.
 - e. Patterson Pump Company.
 - f. Reddy-Buffaloes Pump Co.
 - g. Sterling Peerless Pump; Sterling Fluid Systems Group.
- 2. Pump: Radially split cast-iron casing with suction and discharge flanges machined to ASME B16.1, Class 125 dimensions, unless otherwise indicated.
 - a. Impeller: Cast bronze of construction to match fire pump, statically and dynamically balanced, and keyed to shaft.
 - b. Wear Rings: Replaceable, bronze.
 - c. Shaft and Sleeve: Steel shaft with bronze sleeve.
 - 1) Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
 - 2) Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.
- 3. Driver: UL-listed, NEMA MG 1, open-dripproof, squirrel-cage, induction motor complying with NFPA 20 and NFPA 70. Include wiring compatible with controller used.
 - a. Manufacturers:
 - 1) Emerson; U.S. Electrical Motors.
 - 2) Lincoln Electric Company (The).
 - 3) Marathon Electric, Inc.
 - 4) Weg
- D. Fire-Pump Characteristics and Specialty Data:
 - 1. Fire-Pump Plan No.: FP-1
 - a. Rated Capacity: 500 gpm.
 - b. Total Rated Head: 50 psi.
 - c. Inlet Size: 4-inch
 - d. Outlet Size: 4-inch
 - e. Outlet Flange Class: 125.
 - 2. Speed: Same as driver.
 - 3. Electric-Motor Driver: 25 hp, 3500 rpm, 3 phase, 60 Hz.
 - a. Full-Load Amperes: 34.
 - b. Minimum Circuit Ampacity: 42.5.
 - 4. Test Header Size: 4-inch
 - a. Hose Valves Required: Two.
 - b. Hose Valve Size: NPS 2-1/2.

- 5. Relief Valve Size: 3/4-inch.
- 6. Cone Size: 3/4-inch.

2.03 FIRE-PUMP CONTROLLER

- A. Fire-Pump Controllers, General: UL 218 and NFPA 20; listed for electric-drive, fire-pump service and service entrance; combined automatic and manual operation; factory assembled and wired; and factory tested for capacities and electrical characteristics.
 - 1. Manufacturers:
 - a. Cutler-Hammer.
 - b. Firetrol. Inc.
 - c. Hubbell Industrial Controls, Inc.
 - d. Joslyn Clark.
 - e. Master Control Systems, Inc.
 - f. Metron, Inc.
 - 2. Rate controllers for scheduled fire-pump horsepower and short-circuit withstand rating at least equal to short-circuit current available at controller location. Take into account cable size and distance from substation or supply transformers.
 - 3. Enclosure: UL 50, Type 2, dripproof, indoor, unless special-purpose enclosure is indicated. Include manufacturer's standard red paint applied to factory-assembled and -tested unit before shipping.
 - 4. Controls, devices, alarms, functions, and operations listed in NFPA 20 as required for drivers and controller types used, and specific items listed.
 - a. Isolating means and circuit breaker.
 - b. "Power on" pilot lamp.
 - c. Fire-alarm system connections for indicating motor running condition, loss-of-line power, and line-power phase reversal.
 - d. Automatic and manual operation, and minimum run-time relay to prevent short cycling.
 - e. Water-pressure-actuated switch with independent high and low calibrated adjustments responsive to water pressure in fire-suppression piping.
 - f. Automatic and manual shutdown.
 - g. System pressure recorder, electric ac driven with spring backup.
 - h. Digital solid state starter.
 - 5. Nameplate: Complete with capacity, characteristics, approvals and listings, and other pertinent data.
 - 6. Controller Sensing Pipes: Fabricate pipe and fittings according to NFPA 20 with nonferrous-metal sensing piping, NPS 1/2, with globe valves for testing controller mechanism from system to pump controller as indicated. Include bronze check valve with 3/32-inch orifice in clapper or ground-face union with noncorrosive diaphragm having 3/32-inch orifice.
- B. Full-Service Fire-Pump Controllers:

- 1. Type Starting: Solid state, closed transition, soft starter.
- 2. Mounting: Wall type for field electrical connections.
- C. BACnet Interface Devices:
 - 1. Provide BACnet Interface Devices for each Clean Agent Fire Suppression System so that the units are presented as a series of AV, BV and MSV BACnet objects. See 25 20 21.31.13 for the list of objects that must be supported. This list is the minimum acceptable.

2.04 FIRE-PUMP ACCESSORIES AND SPECIALTIES

- A. Match fire-pump suction and discharge ratings as required for fire-pump capacity rating. Include the following:
 - 1. Automatic air-release valve.
 - 2. Circulation relief valve.
 - 3. Suction and discharge pressure gages.
 - 4. Eccentric-tapered reducer at suction inlet.
 - 5. Concentric-tapered reducer at discharge outlet.
 - 6. Test-Header Manifold: Ductile-iron or brass body for hose valves. Include nozzle outlets arranged in single line; horizontal, flush-wall mounting attachment; and rectangular, rough brass finish escutcheon plate with lettering equivalent to "PUMP TEST CONNECTION."
 - 7. Test-Header Manifold: Ferrous body for hose valves. Manufacturer's standard finish. Include bronze or castiron, exposed-type valve header with nozzle outlets; and round, brass escutcheon plate with lettering equivalent to "PUMP TEST CONNECTION."
 - 8. Hose Valves: UL 668, straightway pattern, and bronze with cap and chain. Include NFPA 1963 hose thread that complies with local fire department standards and finish same as for test-header-manifold escutcheon plate.
 - 9. Ball Drip Valve: UL 1726.
 - 10. Main Relief Valve: UL 1478, pilot operated.
 - 11. Discharge Cone: Open type.
 - 12. Finish: Manufacturer's standard factory-applied red paint unless brass or other finish is specified.

2.05 PRESSURE-MAINTENANCE PUMPS

- A. Pressure-Maintenance Pumps, General: Factory-assembled and -tested pumps with electric-motor driver, controller, and accessories and specialties. Include cast-iron or stainless-steel casing and bronze or stainless-steel impellers, mechanical seals, and suction and discharge flanges machined to ASME B16.1, Class 125 dimensions unless Class 250 flanges are indicated and except that connections may be threaded in sizes where flanges are not available.
 - 1. Finish: Manufacturer's standard color paint applied to factory-assembled and -tested unit before shipping.
 - 2. Nameplate: Complete with capacity, characteristics, and other pertinent data.

- B. Multistage, Pressure-Maintenance Pumps: Multiple-impeller type complying with HI 1.1-1.2 and HI 1.3 requirements for multistage centrifugal pumps. Include base.
 - 1. Manufacturers:
 - a. A-C Pump; ITT Industries.
 - b. Grundfos Pumps Corp.
 - c. Jacuzzi Brothers.
 - d. Paco Pumps, Inc.
 - e. Sterling Peerless Pump; Sterling Fluid Systems Group.
 - f. Taco, Inc.
 - 2. Driver: NEMA MG 1, open-dripproof, squirrel-cage, induction motor complying with NFPA 20 and NFPA 70. Include wiring compatible with controller used.
- C. Regenerative-Turbine, Pressure-Maintenance Pumps: Close-coupled type complying with HI 1.1-1.2 and HI 1.3 requirements for regenerative-turbine centrifugal pumps. Include base.
 - 1. Manufacturers:
 - a. Aurora Pump; Pentair Pump Group.
 - b. Crane Pumps & Systems, Inc.
 - c. Fairbanks Morse; Pentair Pump Group.
 - d. MTH Tool Co., Inc.
 - e. Paco Pumps, Inc.
 - 2. Driver: NEMA MG 1, open-dripproof, squirrel-cage, induction motor complying with NFPA 20 and NFPA 70. Include wiring compatible with controller used.
- D. Controllers: UL 508; factory-assembled, -wired, and -tested, across-the-line type for combined automatic and manual operation.
 - 1. Manufacturers:
 - a. Cutler-Hammer.
 - b. Firetrol, Inc.
 - c. Hubbell Industrial Controls, Inc.
 - d. Joslyn Clark.
 - e. Master Control Systems, Inc.
 - f. Metron, Inc.
 - 2. Enclosure: UL 508 and NEMA 250, Type 2, wall-mounting type for field electrical wiring.
 - a. Finish: Manufacturer's standard color paint applied to factory-assembled and -tested unit before shipping.
 - 3. Rate controller for scheduled horsepower and include the following:
 - a. Fusible disconnect switch.
 - b. Pressure switch.
 - c. Hand-off-auto selector switch.
 - d. Pilot light.
 - e. Running period timer

- E. Accessories and Specialties: Match pressure-maintenance-pump suction and discharge ratings as required for pump capacity rating. Include the following:
 - 1. Circulation relief valve.
 - 2. Suction and discharge pressure gages.
- F. Pressure-Maintenance-Pump Characteristics and Specialty Data:
 - 1. Plan No.: FP-2
 - 2. Rated Capacity: 10 gpm.
 - 3. Total Rated Head: 90 psi.
 - 4. Pump Speed: 3500 rpm.
 - 5. Electric-Motor Driver Size: 1.5 hp, 3500 rpm, 3 phase, 60 Hz.
 - a. Full-Load Amperes: 3.
 - b. Minimum Circuit Ampacity: 4.5.

2.06 ALARM PANELS

- A. Description: Factory-assembled and -wired remote panel complying with UL 508 and requirements in NFPA 20. Include audible and visible alarms matching controller type.
 - 1. Manufacturers:
 - a. Cutler-Hammer.
 - b. Firetrol, Inc.
 - c. Hubbell Industrial Controls, Inc.
 - d. Joslyn Clark.
 - e. Master Control Systems, Inc.
 - f. Metron, Inc.
 - 2. Enclosure: NEMA 250, Type 2, remote wall-mounting type.
 - a. Finish: Manufacturer's standard red paint applied to factory-assembled and -tested unit before shipping.
 - 3. Features: Include manufacturer's standard features and the following:
 - a. Motor-operating condition.
 - b. Loss-of-line power.
 - c. Phase reversal.
 - d. Low-water alarm.

2.07 FLOWMETER SYSTEMS

- A. Description: Fire-pump flowmeter system that indicates flow to not less than 175 percent of fire-pump rated capacity. Include sensor of size to match pipe, tubing, flowmeter, and fittings.
 - 1. FMG-Approved Manufacturers:
 - a. Dieterich Standard Inc.
 - b. Gerand Engineering Co.
 - c. Hyspan Precision Products, Inc.
 - d. Meriam Instruments Div.; Scott Fetzer Co.
 - e. Preso Meters Corporation.

- f. Reddy-Buffaloes Pump Co.
- 2. UL-Listed Manufacturers:
 - a. Fire Research Corp.
 - b. Reddy-Buffaloes Pump Co.
- 3. Pressure Rating: 175-psig minimum.
- 4. Sensor: Venturi, annubar probe, or orifice plate, unless otherwise indicated.
- 5. Flowmeter: Compatible with flow sensor with dial not less than 4-1/2 inches in diameter or manufacturer's equivalent size.
- 6. Permanently Mounted Flowmeter: Suitable for wall mounting with copper tubing to connect to flow sensor.
- 7. Portable Flowmeter: With two 12-foot hoses, in carrying case.

2.08 PRESSURE GAGES

- A. Description: UL 393, 3-1/2- to 4-1/2-inch-diameter dial with range of 0- to 250-psig minimum. Include caption "WATER" on dial face.
 - 1. Manufacturers:
 - a. AGF Manufacturing Co.
 - b. AMETEK, Inc.; U.S. Gauge.
 - c. Brecco Corporation.
 - d. Dresser Equipment Group; Instruments Div.
 - e. Marsh Bellofram.
 - f. WIKA Instrument Corporation.

2.09 GROUT

- A. Description: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

2.10 SOURCE QUALITY CONTROL

- A. Test and inspect fire pumps with their controllers according to NFPA 20 for certified shop tests.
- B. Verification of Performance: Rate fire pumps according to requirements indicated.

PART 3: EXECUTION

3.01 EXAMINATION

A. Examine areas, concrete bases, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of fire pumps.

- B. Examine roughing-in for fire-suppression piping to verify actual locations of piping connections before fire-pump installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 CONCRETE BASES

- A. Install concrete bases of dimensions indicated for fire pumps, pressure-maintenance pumps, and controllers. Refer to Division 21 Section "Common Work Results for Fire Suppression."
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
 - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
- B. Cast-in-place concrete materials and placement requirements are specified in Division 03.

3.03 INSTALLATION

- A. Install and align fire pump, pressure-maintenance pump, and controller according to NFPA 20.
- B. Install pumps and controllers to provide access for periodic maintenance including removal of motors, impellers, couplings, and accessories.
- C. Set base-mounting-type pumps on concrete bases. Disconnect coupling halves before setting. Do not reconnect couplings until alignment operations have been completed.
 - 1. Support pump baseplate on rectangular metal blocks and shims or on metal wedges having small taper, at points near anchor bolts, to provide 3/4- to 1-1/2-inch gap between pump base and concrete base for grouting.
 - 2. Adjust metal supports or wedges until pump and driver shafts are level. Verify that coupling faces and pump suction and discharge flanges are level and plumb.
- D. Install suction and discharge piping equal to or greater than diameter of fire-pump nozzles.
- E. Install valves that are same size as piping connecting fire pumps, bypasses, test headers, and other piping systems.
- F. Install pressure gages on fire-pump suction and discharge at pressure-gage tappings.
- G. Support pumps and piping separately so weight of piping does not rest on pumps.
- H. Install piping accessories, hangers and supports, anchors, valves, meters and gages, and equipment supports.
- I. Install flowmeters and sensors where indicated. Install flowmeter-system components and make connections according to manufacturer's written instructions.
- J. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted. Furnish copies of manufacturers' wiring diagram submittals to electrical Installer.

3.04 INSTALLATION OF BACnet INTERFACE DEVICES

- A. See the Division 25 Responsibility Matrix for the execution responsibilities for Equipment Supplier, Controls and Electrical Subcontractor.
- B. The Equipment Supplier is responsible for supplying and installing the BACnet Interface Device.
- C. Electrical is responsible for power and any control wiring if the device does not have a single point of connection.
- D. Division 25 is responsible for communicating with the BACnet Interface Device using BACnet objects and services to access this data and for mapping the BACnet objects from the device(s) in this Specification Section to the BACnet Object Integration Device to create graphics, reports, trends, alarms, schedules and other requirements specified in Division 25. Division 25 is only responsible for communicating with the BACnet Interface Device using BACnet objects and services to access this data.
- E. This BACnet Interface Device is a BACnet/IP device. See Division 27 for networking responsibilities.

3.05 ALIGNMENT

- A. Align split-case fire-pump and driver shafts after complete unit has been leveled on concrete base, grout has set, and anchor bolts have been tightened.
- B. After alignment is correct, tighten anchor bolts evenly. Fill baseplate completely with grout, with metal blocks and shims or wedges in place. Tighten anchor bolts after grout has hardened. Check alignment and make required corrections.
- C. Align piping connections.
- D. Align pump and driver shafts for angular and parallel alignment according to HI 1.4 and to tolerances specified by manufacturer.
- E. Align vertically mounted, split-case pump and driver shafts after complete unit has been made plumb on concrete base, grout has set, and anchor bolts have been tightened.

3.06 CONNECTIONS

- A. Piping installation requirements are specified in Division 21 Section "Water-Based Fire-Suppression Systems." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to pumps and equipment to allow service and maintenance.
- C. Connect water supply and discharge piping to fire pumps with flexible connectors. Connect water supply and discharge piping to pressure-maintenance pumps with flexible connectors. Refer to Division 21 Section "Water-Based Fire-Suppression Systems" for flexible connectors.
- D. Connect relief-valve discharge to point of disposal.
- E. Connect flowmeter-system sensors and meters according to manufacturer's written instructions.
- F. Connect controllers to pumps.
- G. Connect fire-pump controllers to building fire-alarm system. Refer to Division 28 Section "Fire Detection and Alarm."
- H. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- I. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.07 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust fieldassembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform field tests for each fire pump when installation is complete. Comply with operating instructions and procedures in NFPA 20 to demonstrate compliance with requirements. Where possible, field correct malfunctioning equipment, then retest to demonstrate compliance. Replace equipment that cannot be satisfactorily corrected or that does not perform as indicated, then retest to demonstrate compliance. Verify that each fire pump performs as indicated.
- C. Perform the following field tests and inspections and prepare test reports:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Final Checks before Startup: Perform the following preventive-maintenance operations and checks:
 - a. Lubricate oil-lubrication-type bearings.
 - b. Remove grease-lubrication-type bearing covers, flush bearings with kerosene, and clean thoroughly. Fill with new lubricant according to manufacturer's written instructions.
 - c. Disconnect coupling and check electric motor for proper rotation. Rotation shall match direction of rotation marked on pump casing.
 - d. Verify that pump is free to rotate by hand. If pump is bound or if it drags even slightly, do not operate until cause of trouble is determined and corrected.
 - 3. Starting procedure for pumps is as follows:
 - a. Prime pump by opening suction valve and closing drains, and prepare pump for operation.
 - b. Open sealing-liquid supply valves if pump is so fitted.
 - c. Start motor.
 - d. Open discharge valve slowly.
 - e. Observe leakage from stuffing boxes and adjust sealing-liquid valve for proper flow to ensure lubrication of packing. Do not tighten gland immediately, but let packing run in before reducing leakage through stuffing boxes.
 - f. Check general mechanical operation of pump and motor.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 5. Furnish fire hoses in number, size, and length required to reach storm drain or other acceptable location to dispose of fire-pump test water. Fire hoses are for field-acceptance tests only and are not property of Owner.
 - 6. Refer to 25 08 01, 25 08 02 and 25 20 21.31.13 for start-up and commissioning requirements for the BACnet Interface Devices provided in this Specification Section

3.08 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate and maintain fire pumps. Refer to Division 01 Section "Demonstration and Training."
 - 1. Required Time: 4 hours.
- B. Refer to 25 08 00, 25 08 01, 25 20 21.31.13 for training requirements for the BACnet Interface Devices provided in this Specification Section.

END OF SECTION 21 31 13

SECTION 22 11 24

DOMESTIC-WATER PACKAGED BOOSTER PUMPS

PART 1: GENERAL

1.01 SUMMARY

A. This Section includes variable-speed, multiplex, packaged booster pumps for domestic water piping systems.

B. Related Sections:

- 1. Division 22 Section "Domestic Water Pumps" for domestic water circulation pumps.
- 2. Section 25 20 22.11.24 Integrated Automation BACnet Interface Device (Gateway/Native BACnet Devices) Domestic Water Packaged Booster Pumps (All Types).
- 3. Section 25 00 13 Integrated Automation General Requirements All Trades Work Responsibilities.
- 4. Division 25 Schedule 3 BACnet Single Line Diagram and Responsibility Matrix (Applies to all Trades).

1.02 SUBMITTALS

- A. Product Data: For each packaged booster pump specified. Include certified performance curves with operating points plotted on curves; and rated capacities of selected models, furnished specialties, and accessories.
- B. Shop Drawings: For packaged booster pumps and accessories. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Indicate all dimensions, required clearances, and location of each field connection.
 - 2. System operating profile including pumps, curves, motor, efficiency, horsepower, and kW consumption.
 - 3. Wiring Diagrams: Detail power, signal, and control wiring.
- C. Operation and Maintenance Data: For each packaged booster pump to include in emergency, operation, and maintenance manuals.
- D. Include the BACnet Interface Device with Submittal showing proprietary points listed in 25 20 22.11.24 are mapped to BACnet Object Types. Failure to do so will result in automatic rejection of the Submittal.

1.03 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of packaged booster pumps and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
- 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. ASME Compliance: Comply with ASME B31.9 for piping.
- D. Packaged booster pumps shall be listed and labeled as pumping systems by testing agency acceptable to authorities having jurisdiction.

E. The pumping package shall be certified by an approved independent testing and certification organization as being compliant with the requirements of NSF/ANSI 61 for potable drinking water and NSF-61 Annex G for low lead content.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Retain shipping flange protective covers and protective coatings during storage.
- B. Protect bearings and couplings against damage.
- C. Comply with pump manufacturer's written rigging instructions for handling.

1.05 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.06 WARRANTY

A. The manufacturer shall warrant the water pumping system to be free of defects in material and workmanship for one year (12 months) from date of authorized start-up, not to exceed eighteen (18) months from date of manufacturer's invoice.

PART 2: PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. B&G Bell & Gossett Domestic Pump; ITT Industries
 - 2. Taco

2.02 VARIABLE-SPEED, MULTIPLEX BOOSTER PUMPS

- A. Manufactured units:
 - 1. Manufacturer shall be listed by UL as a manufacturer of packaged pumping systems.
 - 2. Suction and discharge header shall be constructed of 304 stainless steel.
 - 3. The control system shall include, as a minimum, the programmable logic station controller, variable frequency drives, a manifold mounted 4-20mA pressure transducer, and any additional equipment as specified or as required to properly execute the sequence of operation.
 - 4. System shall require only suction, discharge and drain connections and single point power connections from a service entrance disconnect.
 - 5. All components shall be mounted and shipped as a single unit.

- 6. The discharge of each pump shall be fitted with a control valve appropriate for station operation. Each pump and discharge valve assembly shall also be equipped with isolation valves so that the pump can be serviced while system is still filled.
- 7. Pressure gauges shall be installed on the suction and discharge headers.
- 8. Piping shall be sized so that water velocity shall not exceed 10.0 ft/sec in either the branches or manifolds.
- 9. Pumps shall be protected from thermal accumulation via individual thermal relief mechanisms.
- B. Variable Speed Pump Logic Controller:
 - 1. The TechnoForce pump logic controller shall be listed by the Underwriter's Laboratory and bear the UL/cUL label, and shall be certified by BACnet Testing Laboratory and bear the BTL label. The controller shall be specifically designed for packaged pressure booster applications.
 - 2. The variable speed pump control logic shall be capable of accelerating a pump to rated speed (Staging) and decelerating pump to a stop or a specific safe speed (De-Staging). It shall employ various methods to perform staging and de-staging including process variable (PV), end-of-curve EOC), power staging, force de-staging, flow de-staging, time de-staging, and alternation.
 - 3. The programmable logic controller (PLC) and operator interface shall be one integrated unit capable of controlling from 1-to-6 pumps, and supporting English, Spanish and French languages. The controller interface shall have an environmental operating range of 0-to-50° C (<2000 m or 6666 ft), and a 90% RH rating at 40°C.
 - 4. The standard 5.7" color touchscreen interface shall have a landscape format, VGA (640 x 480) resolution, and a LED backlight. Analog input resolution shall be 12-bit minimum. The interface shall have multi-level password protection capability to configure and modify pump and motor parameters. A Quick Start-up Menu screen shall facilitate easy start-up.
 - 5. Interfacing through the color touchscreen display shall be supported with (2) RS485 connections, Ethernet interface, X2X Link interface, Powerlink interface, and a USB 2.0 port.
 - 6. The pressure booster application software shall be held non-volatile 2 GB flash memory with the capability of preventing accidental loss of data and values due to voltage surges and spikes. In the event of a complete power outage, all factory preset, or last saved data values, shall remain stored and available for recall by the operator.
 - 7. The variable speed pump logic program shall provide safeguards against damaging hydraulic conditions including:
 - a. Under-voltage (auto reset configuration option permits 3X fault resets).
 - b. Over-voltage (auto reset configuration option permits 3X fault resets).
 - c. Over-current (auto reset configuration option permits 3X fault resets).
 - d. End-of-curve protection (requires option Flow Meter).
 - e. Low or high system failure.
 - f. Low or high suction pressure.
 - 8. The variable speed pump logic software program ability to detect fault conditions includes:
 - a. Pump failure.
 - b. VFD run failure

- c. VFD communication failure
- d. Low and high system pressure
- e. Low and high suction pressure
- f. Loss of prime (requires optional loss-of-prime sensor/switch).
- g. Low suction prime (requires low suction prime line).
- h. Low and high water (tank) level (requires optional level switches).
- i. Low inlet pressure (requires optional low inlet pressure switch).
- 9. As a minimum, the controller shall have the Inputs and Outputs:
 - a. Digital (8) programmable digit inputs (DI). One DI is dedicated to Local/Remote switch, and rest shall be configurable.
 - b. Three (3) 4-20mA programmable analog inputs (AI) for suction and system pressure transducers and optional flow meter.
 - c. One (1) analog output, 4-20mA signal.
 - d. Two (2) solid state digital outputs.
 - e. Two (2) programmable relay outputs, 230 VAC/5A rating.
- 10. Sensors and transducers:
 - a. Discharge pressure transducer (Standard default).
 - b. Suction pressure transducer shall be connected pump logic and shut down booster if minimum pressure falls below set point (Standard default).
 - c. A backup redundant discharge pressure transducer shall provide continued operation if the primary transducer fails (Optional). A warning light signal shall be given.
 - d. Low suction pressure Switch (Optional).
 - e. Flow meter (Optional).
 - f. Loss of prime assembly (Optional).
 - g. Ship loose transducers; up to 4 zone permissible (Optional).
- 11. No Flow Shutdown (NFSD):
 - a. The pump logic control shall be capable of shutting down the system without the need for a flow meter/switch, once no flow is detected. This system will restart once the system pressure equals a 'restart PSI' set point pressure.
- 12. Pipe fill mode:
 - a. On initial start-up, the booster will slowly fill the system with water. Once the controller detects that the system has been filled, the system pressure is built up over a predetermined ramp-up time.
- 13. Dynamic Flow Loss Compensation
 - a. If a pressure sensor is not located remotely as the point of the critical fixture, the pump logic controller shall be capable of using algorithms to simulate a sensor located at the critical fixture, such that the fiction loss associated with varying flow through the system is compensated for by corresponding set point adjustments. A flow meter shall not be required. The controller will log the last 40 real time set point changes.

- 14. Data Logging:
 - a. The controller shall log last 100 instances covering:

Alarm Log	All alarms
Event Log	All events
Pump Log	Every time a pump is toggled ON/OFF logs time and date. Also includes
	total runtime of each pump.
Data Log	Logs current, lowest and highest values with date and time for all sensors.
	It includes total power consumption (kWh) and total flow of the system.
Operation Log	Logs every time the mode is changed (automatic/manual), VFD failures,
	power cuts and resumes to the system.
Exercise Log	Log time and date every time a pump is exercised.
Setpoint Log	Every time the pressure set point is changed, log old and new set points
	along.
Alternation Log	Every time system alternates, log the new sequence with date & time.
System Reset Log	Every time system resets, log the resetting method with date & time.
Service Log	Log calculated de-stage speed and total operation time of the system.
Error Log	Display B&R system log

- 15. Other Control Features and Functionality is provided:
 - a. Time and date setup.
 - b. Optional flow meter.
 - c. Alarm horn.
 - d. Alarm status.
- C. Variable Speed Drives:
 - 1. VSD's shall be manufacturer's packaged standard drives.
 - 2. At a minimum, the VSDs shall meet or exceed requirements listed in Specification Sections 23 09 50 and 25 20 23.09.50.
- D. Mechanical:
 - 1. Pump Station Frame and Piping:
 - a. Framing shall be designed and fabricated to provide structural support for all attached equipment, and provide anchor bolt support. The base shall supply sufficient rigidity to withstand the stresses of reasonable and competent transportation to site, off loading, installation, and operation.
 - b. Piping shall be constructed from 304 stainless steel, schedule 10 or heavier pipe as required to maintain a 3 to 1 pressure safety factor (including 1/16" corrosion allowance).
 - 2. Centrifugal Pumps:
 - a. End suction Pump.
 - b. 316L construction.
 - c. Premium efficient 3-PH motor, ODP or TEFC enclosure. NEMA design T-frame or JM.
 - 3. Isolation Ball Valves:
 - a. Isolation ball valves shall be certified to NSF-61 for use with potable drinking water.

- b. Isolation ball valves shall be certified as low lead having wetted surface area with a weighted average lead content<0.25%.
- c. Valves shall be rated for 600 psi WOG / 150 psi WSP for valves ¹/₄" to 2" and 400 psi WOG / 125 psi WSP for valves 2-1/2" to 4".
- d. Seats and stem packing shall be virgin PTFE. Stem shall be bottom loaded blowout proof design with fluorocarbon elastomer O-ring to prevent stem leaks.
- e. Valves shall be 2-piece full port design.
- 4. Threaded Check Valves:
 - a. All valve metallic components shall be 316SS.
 - b. Seat shall be Viton.
 - c. Valve shall be rated for 400 psi WOG.
- 5. Wafer Style Silent Check Valve:
 - a. The valve body shall be constructed of ASTM A126 Class B cast iron for Class 125/250 (lead free).
 - b. The seat and double guided disc shall be ASTM B584, C87600 silicon bronze.
 - c. The compression spring shall be ASTM A313 Type 316 Stainless Steel.
 - d. NSF/ANSI 61 & 372 certification.
 - e. The valve design shall incorporate a center guided, spring loaded disc, guided at opposite ends and having a short linear stroke that generates a flow area equal to the nominal valve size.
 - f. The operation of the valve shall not be affected by the position of installation. The valve shall be capable of operating in the horizontal or vertical positions with the flow up or down.
 - g. All component parts shall be field replaceable without the need of special tools. A replaceable guide bushing shall be provided and held in position by the spring. The spring shall be designed to withstand 100,000 cycles without failure and provide a cracking pressure of 0.5 psi.
 - h. The valve disc shall be concave to the flow direction providing for disc stabilization, maximum strength, and a minimum flow velocity to open the valve.
 - i. The valve disc and seat shall have a seating surface finish of 16 micro-inch or better to ensure positive seating at all pressures. The leakage rate shall not exceed the allowable rate for metal seated valves allowed by AWWA Standard C508 or 1 oz (30 ml) per hour per inch (mm) of valve diameter.
 - j. The valve flow way shall be contoured and unrestricted to provide full flow areas at all locations within the valve. Cv flow coefficients shall be equal to or greater than specified below and verified by an independent testing laboratory.
 - k. The valves shall be hydrostatically tested at 1.5 times their rated cold working pressure and seat tested at the valve CWP.
- 6. Sensor/Transmitters:
 - a. Pressure transducer shall be utilized for providing all pressure signals for the pump control logic. Pressure transducer shall be a solid-state bonded strain gage type with an accuracy of $< \pm 0.5\%$ BFSL and constructed of 316 stainless steel. Transducer shall be rated for a pressure of 300 psi and shall provide gauge pressure output, rather than an absolute. Pressure transducer constructed of plastic is not acceptable. Pressure transducer shall be 4-20mA analog type with 10-28 VDC supply range, shall utilize a packard type connector to prevent moisture intrusion, and include surge protection to protect against voltage spikes.

- 7. Flowmeter:
 - a. Field mounted flow sensor transmitter as indicated on the plans. Unit shall transmit an isolated 4-20 mA dc signal indicative of process variable to the pump logic controller via standard two wire 24 VDC system. Unit shall consist of an insertion probe and separately mounted transmitter. The unit shall be accurate to within 1% of flow rate from 1 to 30 fps and shall withstand a static pressure of 200 PSI with negligible change in output.
- 8. Pressure gauges:
 - a. Gauges shall be provided for the suction and discharge manifold.
 - b. Accuracy shall be $\pm 1.5\%$.
 - c. Bourdon tube and connection shall be constructed of 316SS.
 - d. Case, bezel and internals shall be constructed of 316SS.
 - e. Gauge shall be filled with glycerin in order to dampen pulsation and vibration and to provide lubrication to the internal parts.
 - f. Gauge range shall be selected to cover the largest operating range for the specific conditions and pump selected.
- 9. Flange Bolts:
 - a. Bolts shall be zinc plated and shall meet ASTM Grade A193 B7.
- 10. Paint:
 - a. Standard finish coat shall be acrylic enamel to a thickness of no less than 3 mils.
- E. Electrical:
 - 1. Pump Logic Controller Enclosure. Main station disconnect shall have a through door operator and shall be sized as shown in the technical data sheet. Individual integrated fusible drive disconnects shall have exterior operators, and shall be sized as shown in the technical data sheet. Station disconnect panel shall be housed in a NEMA 1 enclosure with integral latches. The control enclosure shall be constructed of 14-gauge steel and the back plate assembly shall be constructed of 14-gauge steel.
 - 2. Controls and Enclosure. The control panel with controls shall be built in accordance with NEC, and shall comply with UL standards. Pump station manufacturer shall be authorized under UL508A to manufacture its own control panels. All equipment and wiring shall be mounted within the enclosure and each device shall be labeled with proper identification. All adjustments and maintenance shall be accessible from the front of the control enclosure. A complete wiring circuit diagram and legend with terminals, components, and wiring completely identified shall be provided. Main disconnect shall be interlocked with door.
 - 3. Station shall have a short circuit current rating (SCCR) OF 5000A.
- F. Sequence of Operations:
 - 1. The system shall consist of a Technologic 1500 pump logic controller with multi-pump parallel operation control, duty-standby pump selection, automatic alternation and automatic transfer to the standby pump upon pump/VFD failure.
 - 2. The pumping system shall start upon the closure of customer's contact when the pump logic controller Mode of Operation is in REMOTE.
 - 3. When the pump logic controller mode in LOCAL, the pumping system shall operate automatically.
 - 4. Each sensor/transmitter shall send a 4-20mA signal to the Technologic 1500 pump logic controller, indicative of process variable condition.

- 5. When the set point is satisfied by the process variable, the pump speed shall remain constant at the optimum energy consumption level.
- 6. The pump controller shall automatically start the lag pumps as necessary to satisfy system demand.
- 7. As demand is satisfied, the controller shall automatically stop lag pumps as necessary to conserve energy.
- 8. In the event of a pump failure or a VFD fault, the pump logic controller automatically initiates a timed sequence of operation to start the redundant pump/VFD set in the variable speed mode.
- 9. In the event of the failure of a zone sensor/transmitter, its process variable signal shall be removed from the scan/compare program. The redundant zone sensor/transmitters, if available, shall remain in the scan/compare program for control.
- 10. PUMP or VFD fault shall be continuously scrolled through the display on the operator interface of the pump logic controller until the fault has been corrected and the controller has been manually reset.
- 11. When the system is satisfied, the pump controller shall shut down the single running lead pump and enter energy saving / no flow shutdown mode.
- G. BACnet Interface Devices:
 - 1. Provide BACnet Interface Devices for each Domestic Water Packaged Booster Pump so that the units are presented as a series of AV, BV and MSV BACnet objects. See 25 20 22.11.24 for the list of objects that must be supported. This list is the minimum acceptable.

2.03 FLEXIBLE CONNECTORS

- A. Manufacturers:
 - 1. Anamet, Inc.
 - 2. Flex-Hose Co., Inc.
 - 3. Flexicraft Industries.
 - 4. Flex-Pression, Ltd.
 - 5. Flex-Weld, Inc.
 - 6. Hyspan Precision Products, Inc.
 - 7. Mercer Rubber.
 - 8. Metraflex, Inc.
 - 9. Proco Products, Inc.
 - 10. Tozen America Corporation.
 - 11. Unaflex Inc.
- B. Description: Corrugated, bronze inner tubing covered with bronze wire braid. Include copper-tube ends or bronze flanged ends, braze-welded to tubing. Include 150-psig minimum working-pressure rating and ends according to the following:
 - 1. NPS 2 and Smaller: Threaded. Provide flanged ends if pump has flanged connections.
 - 2. NPS 2-1/2 and Larger: Flanged.

PART 3: EXECUTION

3.01 EXAMINATION

A. Examine roughing-in for packaged booster pumps to verify actual locations of connections before booster pump installation.

3.02 CONCRETE BASES

- A. Install concrete bases of dimensions indicated for packaged booster pumps. Refer to Division 22 Section "Common Work Results for Plumbing."
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
 - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be imbedded.
 - 4. Install anchor bolts to elevation required for proper attachment to supported equipment.
- B. Cast-in-place concrete materials and placement requirements are specified in Division 03.

3.03 BOOSTER PUMP INSTALLATION

- A. Install equipment in accordance with manufacturer's instructions.
- B. The contractor shall align the pump and motor shafts to within the manufacturer's recommended tolerances prior to system start-up.
- C. Install all control wiring for remote mounted switches and sensor / transmitters. All wiring shall be performed per manufacturer's instructions and applicable state, federal and local codes.
- D. Install packaged booster pumps level on concrete bases with access for periodic maintenance including removal of pumps, motors, impellers, couplings, and accessories.
 - 1. Do not dismantle packaged booster pumps or remove individual components.
- E. Support connected domestic water piping so weight of piping is not supported by packaged booster pumps.

3.04 INSTALLATION OF BACnet INTERFACE DEVICES

- A. See the Division 25 Responsibility Matrix for the execution responsibilities for Equipment Supplier, Controls and Electrical Subcontractor.
- B. The supplier is responsible for supplying and installing the BACnet Interface Device.
- C. Electrical is responsible for power and any control wiring if the device does not have a single point of connection.
- D. Division 25 is responsible for communicating with the BACnet Interface Device using BACnet objects and services to access this data and for mapping the BACnet objects from the device(s) in this Specification Section to the BACnet Object Integration Device to create graphics, reports, trends, alarms, schedules and other requirements specified in Division 25. Division 25 is only responsible for communicating with the BACnet Interface Device using BACnet objects and services to access this data.
- E. This BACnet Interface Device is a BACnet/IP device. See Division 27 for networking responsibilities.
- F. The Equipment Supplier is responsible for networking the VFDs to the onboard Booster Pump Controller that is BACnet/IP. The only external connection is to this BACnet/IP controller.

3.05 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect domestic water piping to packaged booster pumps. Install suction and discharge pipe equal to or greater than size of unit suction and discharge headers.
 - 1. Install flexible connectors on piping connections to unit suction and discharge headers. Install flexible connectors same size as piping.
 - 2. Install shutoff valves on piping connections to each booster pump suction and discharge headers. General-duty valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
 - 3. Install union or flanged connections on pump suction and discharge headers at connection to domestic water piping.
 - 4. Install piping adjacent to packaged booster pumps to allow service and maintenance.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.06 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform the following startup service:
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Check piping connections for tightness.
 - 3. Clean strainers if any.
 - 4. Verify that pump controls are correct for required application.
- B. Perform the following startup checks for each pump of packaged booster pump unit before starting:
 - 1. Verify bearing lubrication.
 - 2. Prime pumps by opening suction valves and closing discharge valves, and prepare pumps for operation.
 - 3. Start motors.
 - 4. Open discharge valves slowly.
 - 5. Adjust settings.
- C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting packaged booster pumps to suit actual occupied conditions. Provide up to two visits to Project outside normal occupancy hours for this purpose.
- D. Refer to 25 08 01, 25 08 02 and 25 20 22.11.24 for start-up and commissioning requirements for the BACnet Interface Devices provided in this Specification Section.
- E. Engage a factory authorized service representative to perform and/or assist with integration of equipment with the Building Automation System as part of the commissioning process. This shall be a separate, second visit at a different date than startup.

3.07 LABELING AND IDENTIFICATION

- A. Install identifying equipment markers and equipment signs on booster pumps. Labeling and identification materials are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."
 3.08 DEMONSTRATION
- A. Train Owner's maintenance personnel to adjust, operate and maintain central-station air handling units. Refer to Division 01 Section "Demonstration and Training."
 - 1. Required Time: 4 hours.

B. Refer to 25 08 00, 25 08 01, 25 20 22.11.24 for training requirements for the BACnet Interface Devices provided in this Specification Section.

END OF SECTION 22 11 24

SECTION 22 11 16

DOMESTIC WATER PIPING

PART 1: GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
 - 2. Encasement for piping.
 - 3. Specialty valves.
 - 4. Flexible connectors.
 - 5. Water meters furnished by utility company for installation by Contractor.
 - 6. Water meters.
 - 7. Escutcheons.
 - 8. Wall penetration systems.

1.02 SUBMITTALS

- A. Product Data: For the following products:
 - 1. Specialty valves.
 - 2. Dielectric fittings.
 - 3. Flexible connectors.
- B. Coordination Drawings: Refer to coordination drawing requirements of 22 05 00.
- C. Field quality-control and test and inspection reports.
- D. Include the BACnet Interface Device with Submittal showing proprietary points listed in 25 07 22.11.16 are mapped to BACnet Object Types. Failure to do so will result in automatic rejection of the Submittal.

1.03 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 61 for potable domestic water piping and components.
- C. Lead Free Requirements: All plumbing pipes, fittings, valves, fixtures, and other components in systems providing water for human consumption shall be 'lead-free' in accordance with the "Reduction of Lead in Drinking Water Act" and the "Safe Drinking Water Act", where the term 'lead-free' is defined to mean "not containing more than 0.2 percent lead when used with respect to solder and flux; and not more than a weighted average of 0.25 percent lead when used with respect to the wetted surfaces of pipes, pipe fittings, plumbing fittings, and fixtures."
 - 1. Lead-free products shall be compliant with the requirements of either NSF 61-G or NSF 372.
 - 2. Lead-free products shall bear a certified mark by a nationally accredited certification body.

1.04 PROJECT CONDITIONS

- A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
 - 1. Notify Owner no fewer than two days in advance of proposed interruption of water service.

1.05 RELATED SECTIONS

- A. Section 25 07 22.11.16 Integrated Automation BACnet Interface Device (Gateway/Native BACnet Devices) Utility Supplied Water Meters (All Types).
- B. Section 25 00 13 Integrated Automation General Requirements All Trades Work Responsibilities.
- C. Division 25 Schedule 3 BACnet Single Line Diagram and Responsibility Matrix (Applies to all Trades).

PART 2: PRODUCTS

2.01 PIPING MATERIALS

A. Comply with requirements in "Piping Applications" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.02 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.
 - 1. Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.
 - 2. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
 - 3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
 - 4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
- B. Soft Copper Tube: ASTM B 88, Type K water tube, annealed temper. Copper Solder-Joint Fittings complying with ASME B16.22, wrought-copper pressure fittings.

2.03 DUCTILE-IRON PIPE AND FITTINGS

- A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
 - 1. Standard-Pattern, Mechanical-Joint Fittings: AWWA C110, ductile or gray iron.
- B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
 - 1. Standard-Pattern, Push-on-Joint Fittings: AWWA C110, ductile or gray iron.
 - a. Gaskets: AWWA C111, rubber.

2.04 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free, unless otherwise indicated; full-face or ring type unless otherwise indicated.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.05 SPECIALTY VALVES

- A. Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty metal valves.
- B. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves, drain valves, backflow preventers, and vacuum breakers.

2.06 TRANSITION FITTINGS

- A. General Requirements:
 - 1. Same size as pipes to be joined.
 - 2. Pressure rating at least equal to pipes to be joined.
 - 3. End connections compatible with pipes to be joined.
- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
- C. Sleeve-Type Transition Coupling: AWWA C219.
- D. Plastic-to-Metal Transition Fittings: CPVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert and one solvent-cement-socket or threaded end.
- E. Plastic-to-Metal Transition Unions: CPVC four-part union. Include brass threaded end, solvent-cement-joint or threaded plastic end, rubber O-ring, and union nut.

2.07 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.
- B. Dielectric Flanges: Factory-fabricated, bolted, companion-flange assembly. Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- C. Dielectric-Flange Kits: 150 psig rated, non-conducting materials for field assembly.
 - 1. Gasket: Neoprene or phenolic.
 - 2. Bolt Sleeves: Phenolic or polyethylene.
 - 3. Washers: Phenolic with steel backing washers.
- D. Dielectric Couplings: 300 psig at 225 degrees F., galvanized steel coupling.
 - 1. End Connections: Female threaded.
 - 2. Lining: Inert and noncorrosive, thermoplastic.
- E. Dielectric Nipples: ASTM F1545, 300 psig at 225 degrees F., electroplated steel nipple.
 - 1. End Connections: Male threaded.
 - 2. Lining: Inert and noncorrosive, propylene.

2.08 FLEXIBLE CONNECTORS

- A. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
 - 1. Working-Pressure Rating: Minimum 200 psig.
 - 2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
 - 3. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.

2.09 WATER METERS

- A. Provide water meter in accordance with all local utility requirements. Any additional water meters required shall comply with requirements of this section.
- B. Turbine-Type Water Meters:
 - 1. Description:
 - a. Standard: AWWA C701.
 - b. Pressure Rating: 150-psig working pressure.
 - c. Body Design: Turbine; totalization meter.
 - d. Registration: In gallons or cubic feet as required by utility company .
 - e. Case: Bronze.
 - f. End Connections for Meters NPS 2 and Smaller: Threaded.
 - g. End Connections for Meters NPS 2-1/2 and Larger: Flanged.
- C. Compound-Type Water Meters:
 - 1. Description:
 - a. Standard: AWWA C702.
 - b. Pressure Rating: 150-psig working pressure.
 - c. Body Design: With integral mainline and bypass meters; totalization meter.
 - d. Registration: In gallons or cubic feet as required by utility company.
 - e. Case: Bronze.
 - f. Pipe Connections: Flanged.
- D. Provide BACnet Interface Devices for each Utility Supplied Water Meter so that the units are presented as a series of AV, BV and MSV BACnet objects. See 25 07 22.11.16 for the list of objects that must be supported. This list is the minimum acceptable.

2.10 ESCUTCHEONS

- A. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.
- B. One Piece, Cast Brass: Polished, chrome-plated finish with setscrews.
- C. One Piece, Deep Pattern: Deep-drawn, box-shaped brass with chrome-plated finish.
- D. Split Casting, Cast Brass: Polished, chrome-plated finish with concealed hinge and setscrew.
- E. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
- F. Split-Casting Floor Plates: Cast brass with concealed hinge.

2.11 GROUT

- A. Standard: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3: EXECUTION

3.01 PIPING APPLICATIONS

A. Above Ground:

- 1. Pipes Tagged 4" or Smaller: Type L, drawn copper tube with wrought coper fittings and solder joints.
- 2. Pipes Tagged 5" or Larger: Type L, drawn coper tube with brazed joints.
- B. Below Ground Water Service Pipe: Push-on-joint, ductile-iron pipe; standard pattern mechanical joint fittings and mechanical joints.
- C. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- D. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

3.02 NOMINAL PIPE SIZE

A. Refer to table below. To determine the required nominal pipe size, select a column corresponding to a pipe material listed in the "Piping Applications" subpart and a row corresponding to the pipe tag indicated on the drawings.

	Ductile Iron		Copper			Polypropylene					Polyethylene		PEX-a			
Pipe tag	Sch	. 40	Тур	e 'L'	Тур	e 'K'	SDF	R- 7.3	SD	R-9	SDR	L-11	DR-	-11	SD	R-9
	NPS	ID	NPS	ID	NPS	ID	NPS	ID	NPS	ID	NPS	ID	NPS	ID	NPS	ID
1/2			1/2	0.55	1/2	0.53	1/2	0.57					1/2	0.68	1/2	0.39
			5/8 0.67	0.67	5/8	0.65	1/2	0.57					1/2	0.08	3/4	0.59
3/4			3/4	0.79	3/4	0.75	3/4	0.71					3/4	0.85	1	0.79
1			1	1.03	1	1.00	1	0.91	1	0.98			1	1.06	1-1/4	0.97
1								0.91	1						1-1/2	1.08
1-1/4			1-1/4	1.27	1-1/4	1.25	1-1/4	1.14	1 - 1/4	1.22	1 - 1/4	1.29	1-1/4	1.34	2	1.48
1-1/2			1-1/2	1.51	1-1/2	1.48	1-1/2	1.43	1-1/2	1.53	1-1/2	1.61	1-1/2	1.53	2	1.48
2		2	2	2 1.99	2	1.96	2	1.80	2	1.93	2 2	2.03	2	1.92	2-1/2	2.01
2							2-1/2	2.14	Z	1.95		2.05			2-1/2	2.01
2-1/2			2-1/2	2.47	2-1/2	2.44	3	2.57	2-1/2	2.30	2-1/2	2.42	3	2.83	3	2.40
3			3	2.95	3	2.91	4	3.14	3	2.90	3	2.90	3	2.83		
3			3	2.95	3	2.91	5	3.57	4	3.37	4	3.54	4	3.63		
4	4	4.28	4	3.91	4	3.86	6	4.57	5	3.83	5	4.03	5	4.49		
5			5	4.88	5	4.81	8	5.72	6	4.90	6	5.15	6	5.35		
6	6	6.40) 6	6 5.85	5 6	5.74	8	5.72	X	6.12	8	6.44	8	6.96		
							10	7.15								
8	8	8.51	8	7.73	8	7.58	12	9.00	10	7.66	10	8.05	10	8.68		

TABLE NO. 22 11 16: NOMINAL PIPE SIZE SELECTION

10	10	10.52	10	9.63	10	9.45	14	10.15	12	9.65	12	10.15	12	10.29					
									14	10.87									
12	12	12.58	12	11.57	12	11.32			16	12.25	14	11.44	14	11.30					
14	14	14.64									16	12.88	16	12.92					
16	16	16.72									18	14.50	18	14.53					
10	10	10.00									20	16 11	20	16.15					
18	18	18.80									20	16.11	22	17.76					
20	20	20.00									22	10.04	24	19.37					
20	20	20	20	20	20 20	20.88	20.00								22	18.04	26	20.99	
24	24	25.04									24	21.89	28	22.61					

Table Notes:

1. NPS: Nominal pipe size.

2. ID: Inner diameter.

3. All dimensions are in inches.

3.03 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.
- E. Soldered Joints: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
- F. Ductile-Iron-Piping Grooved Joints: Cut groove end of pipe. Assemble coupling with housing, gasket, lubricant, and bolts. Join ductile-iron pipe and grooved-end fittings according to AWWA C606 for ductile-iron-pipe, cut-grooved joints.
- G. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
- H. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.04 VALVE APPLICATIONS

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - 1. Shutoff Duty: Use ball valves for piping NPS 2 and smaller. Use ball valves with flanged ends for piping NPS 2-1/2 and larger.
 - 2. Throttling Duty: Use ball or globe valves for piping NPS 2 and smaller. Use ball valves with flanged ends for piping NPS 2-1/2 and larger.
 - 3. Hot-Water Circulation Piping, Balancing Duty: Thermostatic balancing valves.
 - 4. Drain Duty: Hose-end drain valves.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

3.05 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.
- D. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages and Division 22 Section "Domestic Water Piping Specialties" for drain valves and strainers.
- E. Install shutoff valve immediately upstream of each dielectric fitting.
- F. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for pressure-reducing valves.
- G. Install domestic water piping level and plumb.
- H. Install water-meter installation according to utility company's requirements.
- I. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- J. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- K. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- L. Install piping adjacent to equipment and specialties to allow service and maintenance.
- M. Install piping to permit valve servicing.
- N. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.
- O. Install piping free of sags and bends.
- P. Install fittings for changes in direction and branch connections.
- Q. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- R. Install pressure gages on suction and discharge piping from each plumbing pump and packaged booster pump. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages.
- S. Install thermostats in hot-water circulation piping. Comply with requirements in Division 22 Section "Domestic Water Pumps" for thermostats.
- T. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.

U. Install sleeves and mechanical sleeve seals per the requirements of Division 22 Section "Common Work Results for Plumbing".

3.06 VALVE INSTALLATION

- A. General-Duty Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for valve installations.
- B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball valves for piping NPS 4 and smaller.
- C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Division 22 Section "Domestic Water Piping Specialties."
 - 1. Hose-End Drain Valves: At low points in water mains, risers, and branches.
 - 2. Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.
- D. Install thermostatic balancing valves in each hot-water circulation return branch. Set calibrated balancing valves partly open to restrict but not stop flow. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for thermostatic balancing valves.
- E. Install calibrated balancing valves in each master mixing valve assembly and the discharge side of each pump and circulator. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for calibrated balancing valves.

3.07 TRANSITION FITTING INSTALLATION

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Underground Domestic Water Piping:
 - 1. NPS 1-1/2 and Smaller: Fitting-type coupling.
 - 2. NPS 2 and Larger: Sleeve-type coupling.
- C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

3.08 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings or nipples.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges or flange kits.
- D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.09 FLEXIBLE CONNECTOR INSTALLATION

- A. Install flexible connectors in suction and discharge piping connections to each domestic water pump and in suction and discharge manifold connections to each domestic water booster pump.
- B. Install bronze-hose flexible connectors in copper domestic water tubing.

3.10 WATER METER INSTALLATION

A. Rough-in domestic water piping and install water meters according to utility company's requirements.

B. Installation of BACnet Interface Device."

- 1. See the Division 25 Responsibility Matrix for the execution responsibilities for Equipment Supplier, Controls and Electrical Subcontractor.
- 2. The Utility is responsible for supplying the water meter complete with the BACnet Interface Device. Division 23 is responsible for installing the water meter.
- 3. Electrical is responsible for power and any control wiring if the device does not have a single point of connection.
- 4. Division 25 is responsible for communicating with the BACnet Interface Device using BACnet objects and services to access this data and for mapping the BACnet objects from the device(s) in this Specification Section to the BACnet Object Integration Device to create graphics, reports, trends, alarms, schedules and other requirements specified in Division 25.
- 5. This BACnet Interface Device is a BACnet/IP device. See Division 27 for networking responsibilities.

3.11 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.
 - 1. Vertical Piping: MSS Type 8 or 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs: MSS Type 1, adjustable, steel clevis hangers.
 - 3. Multiple, Straight, Horizontal Piping Runs: Field fabricated, heavy duty trapeze. Fabricate from steel shapes required for loads.
- B. Support vertical piping and tubing at base and at each floor.
- C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.
- D. Install supports for vertical copper tubing every 10 feet.
- E. Install supports for vertical steel piping every 15 feet.
- F. Install hangers for horizontal piping with the following minimum rod sizes and maximum spacing for trapeze type hangers with multiple rise runs of varying sizes. The hangers shall be spaced based upon the smallest diameter pipe.

Nom. Pipe	Steel Pipe	Copper Tube	Min. Rod
Size – Inches	Max. Span – Ft.	Max. Span – Ft.	Dia Inches
Up to ³ ⁄ ₄	7	5	3/8
1	7	6	3/8
1-1/4	7	6	3/8
1-1/2	9	6	3/8
2	10	8	3/8
2-1/2	11	9	1/2
3	12	10	1/2
3-1/2	12	10	1/2
4	12	10	1/2
5	12	10	5/8

6	12	10	3/4
8	12	10	7/8

G. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.12 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment and machines to allow service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
 - 1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
 - 2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
 - 3. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 22 Plumbing Fixture Sections for connection sizes.
 - 4. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.13 ESCUTCHEON INSTALLATION

A. Install escutcheons for penetrations of walls, ceilings, and floors. Escutcheons in areas exposed to view shall have a chrome plated finish.

3.14 IDENTIFICATION

- A. Identify system components. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.
- B. Label pressure piping with system operating pressure.

3.15 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Piping Inspections:
 - 1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 - 2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughingin and before setting fixtures.
 - b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

- 3. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
- 4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- C. Piping Tests: The following minimum tests shall be performed. Review procedures with the local jurisdiction and provide any additional tests or procedures required. For manufactured piping systems, pressure/leak test in accordance with the manufacturer's standards.
 - 1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 - 2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
 - 3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 4. Cap and subject piping to static water pressure of 1.5 times the normal operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - 5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
 - 6. Prepare reports for tests and for corrective action required.
- D. Domestic water piping will be considered defective if it does not pass tests and inspections.
- E. Submit test and inspection reports.

3.16 ADJUSTING

- A. Perform the following adjustments before operation:
 - 1. Close drain valves, hydrants, and hose bibbs.
 - 2. Open shutoff valves to fully open position.
 - 3. Open throttling valves to proper setting.
 - 4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
 - b. Adjust calibrated balancing valves to flows indicated.
 - 5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
 - 6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
 - 7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
 - 8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.17 CLEANING

- A. Provide the following minimum cleaning and disinfecting procedures as follows. Notify the Engineer seven (7) days in advance of disinfection procedures.
 - 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 - 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures as described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- B. Prepare and submit reports of purging and disinfecting activities.
- C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.18 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate and maintain the domestic water piping systems. Refer to Division 01 Section "Demonstration and Training."
 - 1. Required Time: As required.
- B. Refer to 25 08 01, 25 08 02 and 25 07 22.11.16 for start-up, commissioning and training requirement for the BACnet Interface Devices provided in this Specification Section.

END OF SECTION 22 11 16

SECTION 23 09 00

BUILDING AUTOMATION SYSTEM

PART 1: GENERAL

1.01 SUMMARY

- A. General Description: Furnish a fully integrated Building Automation System utilizing intelligent distributed control modules for equipment monitoring and control. BAS is hereby defined to include, but not limited to, central computer workstation, input/output (I/O) devices, I/O interfaces, modems, housings, interconnect cabling, valves, sensors, thermostats, dampers, controllers, actuators, and control modules and other panels associated with equipment and required to provide system control functions as indicated on drawings and schedules, and by requirements of this section.
 - 1. The system shall be modular in nature and shall permit expansion of both capacity and function through the addition of sensors, actuators, modular control units, application specific controllers and operator devices.
 - 2. All control system hardware and virtual software points required to accomplish the intent of the control sequences shall be programmed conforming to ASHRAE standard 135 BACnet protocol. It is the intent that the system be programmed with BACnet interoperable objects such that it can be interfaced with other equipment at a future date.
- B. This Section shall be read in conjunction with the Division 25 Specification that covers BACnet Interface Device Integration and BAS infrastructure. Where there is a conflict between 23 09 00 and Division 25, the Division 25 BACnet requirements shall govern. Refer to Division 25 for BACnet Interface Device architecture and networking, graphics and reporting requirements.
- C. Provide assistance and technical support as required to the Testing and Balancing and Functional Performance Contractor to accomplish all testing work required. Upon completion of the self performed tests required in article 3.03 "Quality Control", notify the testing agent in writing that the system is ready for testing. The notification shall include a copy of all self performed checklists. Refer to specification section 23 90 00 for testing agent's testing requirements.
- D. Access to the system, either locally in the building or off site shall be accomplished through standard web browser software via the internet and local area network.
- E. Coordinate with the Owner's representative and associated building technologies groups for the installation of a rack mounted web based server. Conform to the Building Technology requirements.
- F. Provide all variable frequency motor controllers in accordance with all requirements of specification section 23 09 50 "Variable-Frequency Motor Controllers." Provide all variable-frequency controllers as indicated on the drawings and as required to accomplish all control functions required in the sequence of operations. Turn drives over to the Electrical Contractor for installation.
- G. Program systems to accomplish all control functions in accordance with the requirements of Specification Section 23 09 93 "BAS Sequence of Operations."

1.02 ELECTRICAL WORK

- A. Provide the following electrical work as work of this section, complying with all Division 26 and 27 specification requirements:
 - 1. Power supply wiring from power source to power connections on controls and/or control modules. Provide all 24 VAC transformers as required for all control operations. Coordinate with the electrical contractor for the locations and quantities of available spare breakers. Review the Electrical Drawings prior to bid to determine power source locations and voltage. The Building Automation System Contractor is required to provide all transformer installations as required for the available power voltage.
 - a. Any equipment on the emergency electrical system shall be connected to a spare breaker in an equipment branch emergency panelboard. Contractor shall not utilize the life safety or critical branch of emergency power.

- 2. Control wiring between field-installed controls, indicating devices, thermostats and sensors unit control panels.
- 3. Raceways, and Electrical Boxes and Fittings: Provide raceways, and electrical boxes and fittings complying with Division 26 specifications.
- 4. Conduit and junction boxes for all control devices (temperature sensor, thermostats, wall switches, etc.) shall be provided by the Building Automation System Contractor. Route conduit from control device junction boxes in wall up to ceiling/plenum spaces. All wiring in outdoors and in mechanical rooms, electrical rooms, air-handling air streams and similar spaces shall be completely in conduit.
- 5. The Temperature Control Contractor shall provide relays as required for starters of all 120/1-volt equipment not furnished with factory starters, or if starters are not furnished by the Electrical Contractor. Control relays shall be provided in NEMA 1 enclosure.
- 6. All conduit in spaces other than mechanical rooms, boiler rooms, and electrical rooms that is not routed above the ceiling shall be concealed in walls. It is the responsibility of the Building Automation System Subcontractor to coordinate conduit required to be installed in poured concrete walls prior to construction.
- 7. BAS Communications networks shall comply with requirements of Division 27 specifications.
- 8. See Division 25 for additional installation requirements.

1.03 QUALITY ASSURANCE

- A. Contractors shall have a minimum ten years of experience installing and programming control systems. Contractors shall also be factory authorized representative for the control product installed. Submit proof of years of experience and factory authorization upon request.
- B. NEC Compliance: Comply with applicable requirements of NEC pertaining to installation of Building Automation Systems, including, but not limited to, remote-control, signaling and power-limited circuits.
- C. UL Compliance: Provide Building Automation System components and ancillary equipment which are listed and labeled in accordance with UL 864 and UL 916.
- D. NEMA Compliance: Comply with NEMA'S Pub No. 250, and Stds ICS 1, 2, 3 and 6 pertaining to enclosures and controls for Building Automation Systems.
- E. FCC Compliance: Comply with Subpart J of Part 15, Federal Communications Commission Rules, pertaining to Class A radiation and computing devices and low power communication equipment operating in commercial type environment. Comply with Part 68, Federal Communication Commission Rules, pertaining to labeling of telephone equipment, including data sets and modems, indicating FCC registration and numbering.
- F. EIA Compliance: Comply with Electronic Industries Association's Std RS-232 pertaining to interfacing requirements for connecting data terminals and communication equipment.
- G. IEEE Compliance: Comply with IEEE Std 488, "Standard Digital Interface for Programmable Instrumentation", for interfacing instrumentation into system.
- H. ANSI Compliance: Comply with ANSI X3.4, "Code for Information Interchange", requirements for interfacing computer data processing with communication terminal equipment.
- I. NFPA Compliance: Comply with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" where applicable to electronic controls and control sequences.

J. ASHRAE SSPC 135 Compliance: Comply with most recent version of ASHRAE 135-BACnet: A Data Communication Protocol for Building Automation and Control Networks.

1.04 RELATED WORK

- A. Refer to other Division 23 sections for the installation of instrument wells, valve bodies, sensors, flow switches, smoke detectors, and dampers. Coordinate equipment delivery schedules and installation requirements.
- B. Refer to Division 25 for BACnet Interface Device, infrastructure, graphics, commissioning and other requirements.
- C. Section 25 20 23.05.19 Integrated Automation BACnet Interface Device (Gateway/Native BACnet Devices) Flow Meters (All Types)
- D. Section 25 20 23.85.00 Integrated Automation BACnet Interface Device (Gateway/Native BACnet Devices) Air Flow Measuring Stations (All Types)
- E. Section 25 00 13 Integrated Automation General Requirements All Trades Work Responsibilities.
- F. Division 25 Schedule 3 BACnet Single Line Diagram and Responsibility Matrix (Applies to all Trades)

1.05 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for each control device furnished, dampers, valves, sensors, thermostats, etc. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes of materials, and including installation instructions and start-up instructions. Indicate system power connections to electrical power feeders.
- B. Shop Drawings
 - 1. Provide system architecture lay out showing field panels, Application Specific Controllers (ASC), central computer terminal, required network hardware, horizontal and backbone network cabling, tie-in to existing systems, and power panels (see system layout for system requirements).
 - 2. See Division 25 for additional Shop Drawing/Submittal requirements.
 - 3. Provide panel numbering sequence and ASC's submittal showing specific units controlled by each piece of DDC hardware.
 - 4. Provide point address, set points, alarm limits, wire types, conduit knock out diagrams and wiring diagrams for all points of interface.
 - 5. Provide power panel layouts showing number and type of transformers and termination strips. Panels must meet UL listing requirements.
 - 6. Provide technical cut sheets for DDC hardware and sensors.
 - 7. Submit drawings for each system automatically controlled, containing the following information:
 - a. Schematic flow diagram of system showing fans, pumps, coils, dampers, valves, sensors and control devices. List all equipment associated with each system, no general references will be accepted. Include damper and valve failure positions.
 - b. Label each control device with setting or adjustable range of control.
 - c. Indicate factory and field wiring.
 - d. Indicate each control panel required, with internal and external piping and wiring clearly indicated.

Provide detail of panel face, including controls, instruments, and labeling. Include verbal description of sequence of operation.

- C. User Interface Graphics: Submit for review all user interface graphics prior to substantial completion of the project. The Owner reserves the right to modify system graphics prior to final payment.
- D. Wiring Diagrams: Submit power, signal and control wiring diagrams, breaker location and identification, transformer locations, and communication link locations indicating panel-to-panel connections, for Building Automation Systems. Clearly differentiate between portions of wiring that are manufacturer- installed and portions that are field-installed.
- E. Maintenance Data: Submit maintenance instructions and spare parts lists. Include product data and shop drawings in maintenance manual in accordance with requirements of Division 1. Include copy of shop drawings in each maintenance manual in accordance with requirements of Division 1.
- F. Samples: Submit samples of each type of thermostat/temperature sensor, in accordance with requirements of Division 1.
- G. Provide as-built documents at the conclusion of the project to include the following:
 - 1. Thumb drive of all program code.
 - 2. The original source code shall be on the server.
 - 3. Floor plans indicating the locations of all system controllers and all network connections.

1.06 DELIVERY, STORAGE AND HANDLING

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

1.07 WARRANTY

- A. Provide a warranty and maintain the stability of work and materials and keep same in perfect repair and condition for a minimum of two (2) years. The warranty shall be for one (1) year in addition to the one year required by the terms in the front end of these contract documents.
- B. Correct defects of any kind immediately and at Contractor's expense, due to faulty work or materials appearing during the above mentioned period and made to the entire satisfaction of the Owner and Architect/Engineer. Such reconstruction and repairs shall include damage to the finish or the building resulting from the original defect or repairs thereto.

PART 2: PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with requirements, manufacturers offering Building Automation Systems which may be incorporated in the work include the following:
 - 1. Trane
 - 2. Automated Logic
 - 3. Johnson Controls Metasys System Extended Architecture

2.02 BUILDING AUTOMATION SYSTEM – HARDWARE

- A. General: Provide Building Automation Systems with adequate capacity and performance rating to process the number of system points indicated. Comply with manufacturer's standard design, materials, and components; construct in accordance with published product information, as required for complete installation, and as herein specified.
 - 1. The intent of this specification is to provide a peer-to-peer networked, standalone, distributed control system with the capability to integrate both the ASHRAE Standard 135 BACnet communication protocols an open, interoperable system.
 - 2. The supplied computer software shall employ object-oriented technology (OOT) for representation of all data and control devices within the system. In addition, adherence to industry standards including ASHRAETM Standard 135, BACnet to assure interoperability between all system components is required. For each BACnet device, the device must provide a PICS document showing the installed device's compliance level. Minimum compliance is Level 3; with the ability to support data read and write functionality. Physical connection of BACnet devices shall be via Ethernet.
 - 3. All components and controllers supplied under this contract shall be true "peer-to-peer" communicating devices. Components or controllers requiring "polling" by a host to pass data shall not be acceptable.
 - 4. The supplied system must incorporate the ability to access all data using standard Web browsers without requiring proprietary operator interface and configuration programs. An Open Data Base Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data shall reside on a supplier-installed server for all database access. Systems requiring proprietary database and user interface programs shall not be acceptable.
 - 5. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's network system. Systems employing a "flat" single tiered architecture shall not be acceptable.
 - a. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 5 seconds for network connected user interfaces.
 - b. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 60 seconds for remote or dial-up connected user interfaces.
 - 6. Control modules shall be capable of proper operation in an ambient environment of 32°F to 120°F and 10% to 90% relative humidity--non-condensing.
- B. Central Computer Workstation: BAS Subcontractor shall provide the requirements for a Virtual Machine(s) (VMs) provided by Owner to host the Front End graphics, trending, alarming, scheduling and the functions provided by the BAS Subcontractor's software requirements. See Division 25 for additional requirements.
- C. Control Networks
 - 1. Building Automation System Network:
 - a. Provide a microprocessor-based communications data path which shall act as a "peer-to-peer" network allowing all control modules to communicate with equal authority. Provide all network switches, cabling, and devices to achieve the performance requirements herein.
 - b. The network switch devices shall be managed and provide full-duplex communication. The switch packet routing algorithm shall minimize bandwidth consumption. Network hubs or unmanaged switches will not be acceptable.

- c. The BAS network shall be responsible for routing global information from the various control module networks.
- d. The BAS Network shall be a 1 Gigabit/Sec Ethernet network supporting BACnet, Java, XML, HTTP, and CORBA IIOP for maximum flexibility for integration of building data with enterprise information systems and providing support for multiple Network Area Controllers (NACs), user workstations and, if specified, a local host computer system.
- e. BAS network minimum physical and media access requirements:
 - 1) Ethernet; IEEE standard 802.3
 - 2) Cable; 10 Base-T, UTP-8 wire, category 6, Plenum Rated (Type CMP)
 - 3) Minimum throughput; 1 Gbps with backwards compatibility with 10/100 networks.
- f. Provide a connection to the Owner's LAN/WAN at a single point at a location determined by the Owner. All costs associated with extending the network to the point of connection is the responsibility of the contractor. Multiple connections to Owner's network equipment are prohibited.
- g. See the Division 25 BACnet Single Line Diagram for the BAS architecture and BAS hardware requirements.
- 2. Application Specific Controller (ASC) Network
 - a. ASC Controllers shall be used for direct digital control of selected single zone equipment. They shall be microprocessor based. In the event of loss of communication with the network, the controller shall function in a stand-alone mode, with all control sequences and schedules performed. Provide user-defined default algorithms (values) for global points affecting the operation of the ASC, such as outside lights levels, outside temperatures, status of heating system, etc.
- D. Network Area Controller (NAC)
 - 1. Provide one or more Network Area Controllers (NAC) as required to interface between the Building Automation Network and the field control devices, and provide global supervisory control functions over the control devices connected to the NAC. NAC controllers shall present data in accordance with BACnet ASHRAE Standard 135. It shall be capable of executing application control programs to provide:
 - a. Calendar functions
 - b. Scheduling
 - c. Trending
 - d. Alarm monitoring and routing
 - e. Time synchronization
 - f. Integration BACnet controller data.
 - 2. The Network Area Controller must provide the following hardware features as a minimum:
 - a. One Ethernet Port -10 / 100 Mbps
 - b. One RS-232 port
 - c. Battery Backup
 - d. Flash memory for long term data backup (If battery backup or flash memory is not supplied, the controller must contain a hard disk with at least 1 gigabyte storage capacity)
 - e. The NAC must be capable of operation over a temperature range of 0 to 55°C
 - f. The NAC must be capable of withstanding storage temperatures of between 0 and 70°C
 - g. The NAC must be capable of operation over a humidity range of 5 to 95% RH, non-condensing
 - 3. The NAC shall provide multiple user access to the system. A database resident on the NAC shall provide a data access mechanism to read and write data stored within it.

- 4. The NAC shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 16 simultaneous users.
- 5. The NAC shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
- 6. The NAC shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via dial-up, telephone connection, or wide-area network. Provide at a minimum eight alarm classes for the purpose of routing types.
- 7. Alarm data recorded for each alarm shall include the time and date, location, equipment, acknowledge time and date, number of occurrences since last acknowledgement.
- 8. The NAC shall have the ability to collect data for any property of any object and store this data for future use.
- 9. All log data shall be stored in a relational database in the NAC and the data shall be accessed from a server (if the system is so configured) or a standard Web Browser.
- 10. Provide and maintain an Audit Log that tracks all activities performed on the NAC. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached it's user-defined buffer size. Provide the ability to archive the log locally (to the NAC), to another NAC on the network, or to a server.
- 11. The NAC shall have the ability to automatically backup its database. The database shall be backed up based on a user-defined time interval.
- 12. Each (NAC) shall be capable of stand-alone direct digital operation utilizing its own processor, non-volatile memory, input/output, A to D conversion, clock/calendar and voltage transient protection. All volatile memory shall have a battery backup.
- 13. All point data, algorithms and application software within an (NAC) network shall be modifiable from the Central workstation. It shall not be necessary to enter parameters at the (NAC) for control and programs to operate.
- 14. Each (NAC) shall execute application programs, calculations, and commands via a microcomputer resident in the (NAC). The database and all application programs for each (NAC) shall be stored in read/write non-volatile memory within the (NAC) and shall be able to upload/download to or from the Central Site.
- 15. Each (NAC) shall be connected to the BAS network for communicating to/from other Control modules. Each (NAC) shall include self-test diagnostics which allow the (NAC) to automatically relay any malfunctions of alarm conditions that exceed desired parameters as determined by programming input to the network.
- 16. Each (NAC) shall contain both software and hardware to perform full DDC/PID control loops.
- E. Database Backup and Storage
 - 1. The NAC shall have the ability to automatically backup its database. The database shall be backed up based on an user-defined time interval.
 - 2. Copies of the current database and, at the most recently saved database shall be stored in the NAC. The age of the most recently saved database is dependent on the user-defined database save interval.
 - 3. The NAC database shall be stored, at a minimum, in XML format to allow for user viewing and editing, if desired. Other formats are acceptable as well, as long as XML format is supported.

- F. Web Server
 - 1. The server shall support all Network Area Controllers (NAC) connected to the customer's network whether local or remote. Web server shall be rack mounted at a location coordinated with the Owner's representative and associated building technologies groups. Conform to all the Owner's representative networking requirements.
 - 2. Local connections shall be via an Ethernet LAN. Remote connections can be via ISDN, ADSL, T1 or dial-up connection.
 - 3. It shall be possible to provide access to all Network Area Controllers via a single connection to the server. In this configuration, each Network Area Controller can be accessed from the Graphical User Interface (GUI) or from a standard Web browser Interface (WBI) by connecting to the server.
 - 4. The server shall provide the following functions, at a minimum:
 - a. Global Data Access: The server shall provide complete access to distributed data defined anywhere in the system.
 - b. Distributed Control: The server shall provide the ability to execute global control strategies based on control and data objects in any NAC in the network, local or remote.
 - c. The server shall include a master clock service for its subsystems and provide time synchronization for all Network Area Controllers (NAC).
 - d. The server shall accept time synchronization messages from trusted precision Atomic Clock Internet sites and update its master clock based on this data.
 - e. The server shall provide scheduling for all Network Area Controllers and their underlying field control devices.
 - f. The server shall provide demand limiting that operates across all Network Area Controllers. The server must be capable of multiple demand programs for sites with multiple meters and or multiple sources of energy. Each demand program shall be capable of supporting separate demand shed lists for effective demand control.
 - g. The server shall implement the BACnet Command Prioritization scheme (16 levels) for safe and effective contention resolution of all commands issued to Network Area Controllers. Systems not employing this prioritization shall not be accepted.
 - h. Each Network Area Controller supported by the server shall have the ability to archive its log data, alarm data and database to the server, automatically. Archiving options shall be user-defined including archive time and archive frequency.
 - i. The server shall provide central alarm management for all Network Area Controllers supported by the server. Alarm management shall include:
 - 1.) Routing of alarms to display, printer, email and pagers
 - 2.) View and acknowledge of alarms
 - 3.) Query alarm logs based on user-defined parameters
 - j. The server shall provide central management of log data for all Network Area Controllers supported by the server. Log data shall include process logs, runtime and event counter logs, audit logs and error logs. Log data management shall include:
 - 1.) Viewing and printing log data
 - 2.) Exporting log data to other software applications

- 3.) Query log data based on user-defined parameters
- G. Application Specific Control Modules (ASC)
 - 1. Provide one of the following ASC's:
 - a. ASC Modules shall be microprocessor based Interoperable Controllers that shall communicate in BACnet ASHRAE Standard 135 open protocol. ASC's shall be capable of providing the direct digital control of single zone Terminal HVAC Units, Unit Ventilators, Fan Coils, Heat Pumps, Variable Air Volume (VAV) Terminals and other applications as shown on the drawings. The application control program shall be resident within the same enclosure as the input/output circuitry, which translates the sensor signals. The system supplier must provide a PICS document showing the installed systems compliance level to the ASHRAE Standard 135. Minimum compliance is Level 3.
 - 2. The ASC's shall communicate with the NAC via an Ethernet connection at a baud rate of not less than 10 Mbps.
 - 3. The ASC Sensor shall connect directly to the ASC and shall not utilize any of the I/O points of the controller. The ASC Sensor shall provide a two-wire connection to the controller that is polarity and wire type insensitive. The ASC Sensor shall provide a communications jack for connection to the BACnet communication trunk to which the ASC controller is connected. The ASC Sensor, the connected controller, and all other devices on the BACnet bus shall be accessible by the POT.
 - 4. All ASC's shall be fully application programmable and shall at all times maintain their BACnet Level 3 compliance. Controllers offering application selection only (non-programmable), require a 10% spare point capacity to be provided for all applications. All control sequences within or programmed into the ASC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained.
 - 5. All control applications shall be field-selectable such that a single controller may be used in conjunction with any of the above types of terminal units.
 - 6. Each ASC shall communicate with equal authority on a "peer-to-peer" basis.
 - 7. Each ASC shall execute application programs, calculations, and commands via a microcomputer resident in the ASC. The database and all application programs for each ASC shall be stored in read/writable non-volatile memory. All volatile memory shall have a battery backup.
 - 8. Each ASC shall contain both software and hardware to perform full DDC/PID control loops. ASC shall be able to provide analog output, in addition to normal binary type output.
 - 9. Control modules shall include all point inputs and outputs necessary to perform the specified control sequences. As a minimum, 50% of the point outputs shall be of the Universal type. Analog outputs shall be industry standard signals (e.g. 24V floating control) allowing for interface to a variety of modulating actuators.
 - 10. The control modules shall be powered from a 24 VAC source and shall function normally under an operating range of 18 to 28 VAC(-25% to +17%), allowing for power source fluctuations and voltage drops. Provide each module with a suitable cover or enclosure to protect the intelligence board assembly.
 - 11. Each ASC shall have LED indication for visual status of communication, power, and all outputs.
 - 12. Each controller shall include provisions for manual and automatic calibration of associated transducers in order to maintain stability and control drift over time.

- 13. The module shall interface to a variety of matching electronic room temperature sensors of the RTD or thermistor type with the following characteristics:
 - a. Independent setpoint modes for heating, cooling, and Night Setback.
 - b. Tamperproof locking cover.
 - c. Allow installation up to 100 ft from controller.
- 14. Controller points and set points shall be accessible from the central workstation and from a plug in jack at the base of each controller's sensor.
- 15. Contractor shall field verify operation of all controllers to insure correct field wiring, test actuator stroke, and correlate with controller submittal.
- 16. Contractor shall provide a POT and instructions to the balancer to read and adjust system perimeters for the balancing report.
- H. Interoperable BACnet Controller (IBC)
 - 1. Controls shall be microprocessor based Interoperable Controllers that shall communicate in the BACnet ASHRAE Standard 135 open protocol. IBCs shall be provided for each Variable Air Volume (VAV) Terminals and other applications as shown on the drawings. The application control program shall be resident within the same enclosure as the input/output circuitry, which translates the sensor signals. The system supplier shall provide a PICS document upon request from the Engineer showing the installed systems compliance level to the ASHRAE Standard 135. Minimum compliance is Level 3.
 - 2. The IBCs shall communicate with the NAC via an Ethernet connection at a baud rate of not less than 10 Mbps.
 - 3. The IBC Sensor shall connect directly to the IBC and shall not utilize any of the I/O points of the controller. The IBC Sensor shall provide a two-wire connection to the controller that is polarity and wire type insensitive. The IBC Sensor shall provide a communications jack for connection to the BACnet communication trunk to which the IBC controller is connected. The IBC Sensor, the connected controller, and all other devices on the BACnet bus shall be accessible by the POT.
 - 4. All IBCs shall be fully application programmable and shall at all times maintain their BACnet Level 3 compliance. Controllers offering application selection only (non-programmable), require a 10% spare point capacity to be provided for all applications. All control sequences within or programmed into the IBC shall be stored in a non-volatile memory, which is not dependent upon the presence of a battery, to be retained.
 - 5. Provide documentation for each device upon request from the Engineer, with the following information at a minimum:
 - a. BACnet Device; MAC address, name, type and instance number
 - b. BACnet Objects; name, type and instance number
 - c. All BACnet Device and point names, instance numbers and network numbers shall be approved by the Engineer per the requirements of Division 25.
- I. Fault-Tolerance: Select components to operate over a wide range of supply voltage and frequency, with static, transient and short-circuit protection on all inputs and outputs. Protect communication lines against incorrect wiring, static transients and induced magnetic interference. Provide AC coupled devices for connection to communication network to limit device time-outs.

2.03 GRAPHICAL USER INTERFACE SOFTWARE

A. See Division 25 for graphical user interface software requirements.

2.04 WEB BROWSER CLIENTS

- A. The system shall be capable of supporting an unlimited number of clients using a standard Web browser such as Internet Explorer[™], Google Chrome, or Mozilla Firefox. Systems requiring additional software (to enable a standard Web browser) to be resident on the client machine, or manufacture-specific browsers shall not be acceptable.
- B. The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Systems that require specific machine requirements in terms of processor speed, memory, etc., in order to allow the Web browser to function with the BAS, shall not be acceptable.
- C. 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. Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.
- D. The Web browser client shall support at a minimum, the following functions:
 - 1. User log-in identification and password shall be required. If an unauthorized user attempts access, a black web page shall be displayed. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.
 - 2. Graphical screens developed for the GUI shall be the same screens used for the Web browser client. Any animated graphical objects supported by the GUI shall be supported by the Web browser interface.
 - 3. HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.
 - 4. Storage of the graphical screens shall be in the Network Area Controller (NAC), without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.
 - 5. Real-time values displayed on a Web page shall update automatically without requiring a manual "refresh" of the Web page.
 - 6. Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:
 - a. Modify common application objects, such as schedules, calendars, and set points in a graphical manner.
 - 1) Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
 - 2) Holidays shall be set using a graphical calendar, without requiring any keyboard entry from the operator.
 - b. 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.
 - c. View logs and charts.
 - d. View and acknowledge alarms.
 - e. Setup and execute SQL queries on log and archive information.

- 7. The system shall provide the capability to specify a user's (as determined by the log-on user identification) home page. Provide the ability to limit a specific user to just their defined home page. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.
- 8. Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired line.

2.05 SYSTEM PROGRAMMING

A. See Division 25 for system programming requirements.

2.06 OBJECT LIBRARIES

- A. A standard library of objects shall be included for development and setup of application logic, user interface displays, system services, and communication networks.
- B. The objects in this library shall be capable of being copied and pasted into the user's database and shall be organized according to their function. In addition, the user shall have the capability to group objects created in their application and store the new instances of these objects in a user-defined library.
- C. In addition to the standard libraries specified here, the supplier of the system shall maintain an on-line accessible (over the Internet) library, available to all registered users to provide new or updated objects and applications as they are developed.
- D. All control objects shall conform to the control objects specified in the BACnet specification.
- E. The library shall include applications or objects for the following functions, at a minimum:
 - 1. Scheduling Object. The schedule must conform to the schedule object as defined in the BACnet specification, providing 7-day plus holiday & temporary scheduling features and a minimum of 10 on/off events per day. Data entry to be by graphical sliders to speed creation and selection of on/off events.
 - 2. Calendar Object. The calendar must conform to the calendar object as defined in the BACnet specification, providing 12-month calendar features to allow for holiday or special event data entry. Data entry to be by graphical "point-and-click" selection. This object must be "linkable" to any or all scheduling objects for effective event control.
 - 3. Duty Cycling Object. Provide a universal duty cycle object to allow repetitive on/off time control of equipment as an energy conserving measure. Any number of these objects may be created to control equipment at varying intervals
 - 4. Temperature Override Object. Provide a temperature override object that is capable of overriding equipment turned off by other energy saving programs (scheduling, duty cycling etc.) to maintain occupant comfort or for equipment freeze protection.
 - 5. Start-Stop Time Optimization Object. Provide a start-stop time optimization object to provide the capability of starting equipment just early enough to bring space conditions to desired conditions by the scheduled occupancy time. Also, allow equipment to be stopped before the scheduled un-occupancy time just far enough ahead to take advantage of the building's "flywheel" effect for energy savings. Provide automatic tuning of all start/stop time object properties based on the previous day's performance.

- 6. Demand Limiting Object. Provide a comprehensive demand-limiting object that is capable of controlling demand for any selected energy utility (electric, oil, and gas). The object shall provide the capability of monitoring a demand value and predicting (by use of a sliding window prediction algorithm) the demand at the end of the user defined interval period (1-60 minutes). This object shall also accommodate a utility meter time sync pulse for fixed interval demand control. Upon a prediction that will exceed the user defined demand limit (supply a minimum of 6 per day), the demand limiting object shall issue shed commands to either turn off user specified loads or modify equipment set points to effect the desired energy reduction. If the list of sheddable equipment is not enough to reduce the demand to below the set point, a message shall be displayed on the users screen (as an alarm) instructing the user to take manual actions to maintain the desired demand. The shed lists are specified by the user and shall be selectable to be shed in either a fixed or rotating order to control which equipment is shed the most often. Upon suitable reductions in demand, the demand-limiting object shall restore the equipment that was shed in the reverse order in which it was shed. Each sheddable object shall have a minimum and maximum shed time property to effect both equipment protection and occupant comfort.
- F. The library shall include control objects for the following functions. All control objects shall conform to the objects as specified in the BACnet specification.
 - 1. Analog Input Object -Minimum requirement is to comply with the BACnet standard for data sharing. Allow high, low and failure limits to be assigned for alarming. Also, provide a time delay filter property to prevent nuisance alarms caused by temporary excursions above or below the user defined alarm limits.
 - 2. Analog Output Object -Minimum requirement is to comply with the BACnet standard for data sharing.
 - 3. Binary Input Object -Minimum requirement is to comply with the BACnet standard for data sharing. The user must be able to specify either input condition for alarming. This object must also include the capability to record equipment run-time by counting the amount of time the hardware input is in an "on" condition. The user must be able to specify either input condition as the "on" condition.
 - 4. Binary Output Object -Minimum requirement is to comply with the BACnet standard for data sharing. Properties to enable minimum on and off times for equipment protection as well as interstart delay must be provided. The BACnet Command Prioritization priority scheme shall be incorporated to allow multiple control applications to execute commands on this object with the highest priority command being invoked. Provide sixteen levels of priority as a minimum. Systems not employing the BACnet method of contention resolution shall not be acceptable.
 - 5. PID Control Loop Object -Minimum requirement is to comply with the BACnet standard for data sharing. Each individual property must be adjustable as well as to be disabled to allow proportional control only, or proportional with integral control, as well as proportional, integral and derivative control.
 - 6. Comparison Object -Allow a minimum of two analog objects to be compared to select either the highest, lowest, or equality between the two linked inputs. Also, allow limits to be applied to the output value for alarm generation.
 - 7. Math Object -Allow a minimum of four analog objects to be tested for the minimum or maximum, or the sum, difference, or average of linked objects. Also, allow limits to be applied to the output value for alarm generation.
 - 8. Custom Programming Objects -Provide a blank object template for the creation of new custom objects to meet specific user application requirements. This object must provide a simple BASIC- like programming language that is used to define object behavior. Provide a library of functions including math and logic functions, string manipulation, and e-mail as a minimum. Also, provide a comprehensive on-line debug tool to allow complete testing of the new object. Allow new objects to be stored in the library for re-use.

- 9. Interlock Object -Provide an interlock object that provides a means of coordination of objects within a piece of equipment such as an Air Handler or other similar types of equipment. An example is to link the return fan to the supply fan such that when the supply fan is started, the return fan object is also started automatically without the user having to issue separate commands or to link each object to a schedule object. In addition, the control loops, damper objects, and alarm monitoring (such as return air, supply air, and mixed air temperature objects) will be inhibited from alarming during a user-defined period after startup to allow for stabilization. When the air handler is stopped, the interlocked return fan is also stopped, the outside air damper is closed, and other related objects within the air handler unit are inhibited from alarming nuisance alarms during the off period.
- 10. Temperature Override Object -Provide an object whose purpose is to provide the capability of overriding a binary output to an "On" state in the event a user specified high or low limit value is exceeded. This object is to be linked to the desired binary output object as well as to an analog object for temperature monitoring, to cause the override to be enabled. This object will execute a Start command at the Temperature Override level of start/stop command priority unless changed by the user.
- 11. Composite Object -Provide a container object that allows a collection of objects representing an application to be encapsulated to protect the application from tampering, or to more easily represent large applications. This object must have the ability to allow the user to select the appropriate parameters of the "contained" application that are represented on the graphical shell of this container.
- G. The object library shall include objects to support the integration of devices connected to the Network Area Controller (NAC). At a minimum, provide the following as part of the standard library included with the programming software:
 - 1. For BACnet devices, provide the following objects at a minimum:
 - a. BACnet AI.
 - b. BACnet AO
 - c. BACnet BI
 - d. BACnet BO
 - e. BACnet Device
 - 2. For each BACnet object, provide the ability to assign the object a BACnet device and object instance number.

2.07 MATERIALS AND EQUIPMENT

- A. General Description: Furnish direct digital electronic control products in sizes and capacities indicated, including valves, dampers, thermostats, clocks, sensors, controllers, and other components required for complete installation. Except as otherwise indicated, provide manufacturer's standard control system components as indicated by published product information, designed and constructed as recommended by manufacturer. Provide direct digital electronic control systems with the following functional and construction features, as indicated.
- B. Control Valves: Provide factory-fabricated electronic control valves of type, body material and pressure class indicated. Where type or body material is not indicated, provide selection as determined by manufacturer for installation requirements and pressure class, based on maximum pressure and temperature rating of piping system. Except as otherwise indicated, provide valves which mate and match material of connecting piping. Equip control valves with control valve motors and with proper shutoff ratings for each individual application.
 - 1. Water Service Valves: Globe screwed, equal percentage characteristics with rangeability of 50 to 1, and maximum full flow pressure drop of 5 psig. Motorized ball valves will be acceptable. Motorized butterfly valves will not be acceptable.
 - 2. Single-Seated Valves: Cage type trim, providing seating and guiding surfaces for plug on "top and bottom" guided plugs.
 - 3. Double-Seated Valves: Balanced plug-type, with cage type trim providing seating and guiding surfaces for

plugs on "top and bottom" guided plugs.

- 4. Valve Trim and Stems: Polished stainless steel.
- 5. Packing: ½"-3/4" double O-ring; 1" and above spring-loaded Teflon, self-adjusting.
- 6. Terminal Unit Control Valves: Provide control valves for control of terminal units including, but not necessarily limited to, convectors, finned tube radiation, and HW coils that are of integral motor type. Provide modulating type valves, electrically actuated by line voltage of 24 Volt.
- C. Dampers: Provide automatic control dampers as indicated, with damper frames not less than formed 13-ga. galvanized steel. Provide mounting holes for enclosed duct mounting. Provide damper blades not less than formed 16-ga. galvanized steel, with maximum blade width of 8". Equip dampers with motors, with proper rating for each application.
 - 1. Secure blades to 1/2" diameter zinc-plated axles using zinc-plated hardware. Seal off against spring stainless steel blade bearings. Provide blade bearings of nylon and provide thrust bearings at each end of every blade. Construct blade linkage hardware of zinc-plated steel and brass. Submit leakage and flow characteristic, plus size schedule for controlled dampers.
 - 2. Operating Temperature Range: From -20 to 200oF.
 - 3. For standard applications other than outside air dampers, provide parallel blade design (as selected by manufacturer's sizing techniques) with optional closed-cell neoprene edging.
 - 4. Outside air dampers shall be parallel blade design (as selected by manufacturer's sizing techniques) with inflatable seal blade edging, or replaceable rubber seals, rated for leakage at less than 10 cfm/sq. ft. of damper area, at differential pressure of 4" w.g. when damper is being held by torque of 50 inch-pounds.
- D. Electric Actuators: Size each motor to operate dampers or valves with sufficient reserve power to provide smooth modulating action or 2-position action as specified. Provide multiple operators to match torque requirements. Control valves and actuators shall be provided to fail to the position indicated in Part 3.0 of this specification section.
 - 1. Electronic actuators shall be direct coupled with a manual override feature and spring return.
 - 2. The actuator shall be direct-coupled over the damper shaft, enabling it to mount directly to the damper assembly without the need for connecting linkage. The fastening clamp assembly shall be a toothed "V" bolt design with associated toothed cradle, creating a "cold-weld" attachment to the damper shaft for maximum strength and eliminating slippage. Spring return actuators shall have a "V" clamp assembly of sufficient size to be directed to a damper jackshaft up to 1.05 inches in diameter when the damper is constructed in this manner. Single bolt or setscrew type fasteners are not acceptable.
 - 3. The actuator shall have an electronic overload or digital rotation sensing circuitry to prevent damage to the actuator through the entire rotation of the actuator. Mechanical end switches or magnetic clutches used to deactivate the actuator at the end of rotation are not acceptable.
 - 4. For power-failure and/or safety applications, and internal mechanical spring return mechanism shall be built into the actuator housing. Non-mechanical forms of fail-safe operation are not acceptable. All spring return actuators shall be capable of both clockwise and counter-clockwise spring return operation by simply changing the actuator mounting orientation. Spring-return actuators shall deliver full torque capacity ratings of the actuator when operating in the fail-safe mode.
 - 5. Proportional (modulating) actuators shall accept a 0 to 10 VDC or 0 to 20 mA control input and provide a 2 to 10 VDC or 4 to 20 mA control operating range. Actuators utilizing Pulse Width Modulating or Tri-State control signals and providing full proportional control of the damper shall also be acceptable. All modulating actuators shall provide 2 to 10 VDC position feedback signal.

- 6. All 24 VAC/VDC actuators shall operate on Class 2 wiring and shall not require more than 10 VA for AC power or more than 8 watts for DC applications. Actuators operating on 120 VAC shall not require more than 10 VA. Actuators operating on 230 VAC shall not require more than 11 VA.
- 7. All non-spring return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring return actuators with more than 60 in-lb torque capacity shall have an external, manual crank for this purpose.
- 8. All modulating actuators shall have an external, built-in switch to allow the reversing of the direction of rotation.
- 9. All actuators shall be provided with a conduit fitting and pre-terminated three-foot (minimum) cable, with wires color and/or number coded. Where installation does not require conduit, external terminal strips may be used. At no time shall it be necessary to open the actuator housing to make electrical connections, change direction of rotation, provide damper position indication or manual overrides.
- 10. All actuators shall be listed under UL Standard 873 and CSA Class 4813-02 certified as required to meet recognized industry standards and local safety and electrical codes.
- 11. Actuators shall be designed to deliver a minimum of 60,000 full stroke cycles at the actuators rated torque. Actuators shall have a full manufacturer's warranty of 2 years from the time of installation.
- E. Remote-Bulb Thermostats: Provide remote-bulb thermostats of on/off or modulating type, as required by sequence of operation. Provide liquid-filled units designed to compensate for changes in ambient temperature at instrument case. Provide capillary and bulb of copper unless otherwise indicated. Equip bulbs in water lines with separate wells of same material as bulb. Support bulbs installed in air ducts securely, to prevent damage and noise from vibrations. Provide averaging bulbs where shown or specified in operational sequence, consisting of copper tubing not less than 8'-0" in length with either single or multiple-unit elements. Extend tubing to cover full width of duct or unit, and support adequately.
 - 1. Provide scale settings and differential settings where applicable, which are clearly visible and adjustable from front of instrument.
 - 2. Equip on-off remote-bulb thermostats with precision snap switches, and with electrical ratings as required by application.
 - 3. Provide modulating remote-bulb thermostats of potentiometer type constructed so that complete potentiometer coil and wiper assembly is removable for inspection or replacement without disturbing calibration of instrument.
- F. Low-Temperature Protection Thermostats: Provide low-temperature protection thermostats of manual-reset type, with sensing elements 8'-0" or 20'-0" in length. Provide thermostat designed to operate in response to coldest 1'-0" length of sensing element, regardless of temperature at other parts of element. Support element properly to cover entire cross sectional area at duct. Provide separate thermostats for each 25 sq. ft. of coil face area or fraction thereof.
- G. Electronic Temperature Sensors: Provide electronic temperature sensors of supersensitive resistance type (RTD) or thermistor, which are vibration and corrosion-resistant, and of wall mounted, immersion, duct mounting, averaging or bulb type as required for application.
- H. Wall Mounted Space Temperature Sensor (Non-Adjustable): Provide electronic temperature sensors of supersensitive resistance type (RTD) or thermistor which are vibration and corrosion resistant. The sensing element shall be adhered to a flat stainless steel plate and be vandal resistant.
- I. Wall Mounted Space Temperature Sensor (Adjustable): Provide device with electronic display and temperature sensors of supersensitive resistance type (RTD) or thermistor which are vibration and corrosion resistant. At minimum, device shall include local user setpoint adjustment capability and a space temperature read-out. Set point adjustment range and display information for reprogrammable devices shall be reviewed and approved by the

Owner prior to implementation. Provide a protective guard where indicated in Part 3 and where indicated on the drawings. The protective guard shall be constructed from a clear heavy-duty polycarbonate material, with holes to freely circulate air for proper sensor operation, access for making setpoint adjustments, a wall mounting plate, and mounting hardware.

- J. Insulation for wall mounted space temperature sensors: Closed-cell type with a flame-spread index of 25 or less and a smoke-developed index of 50 or less when tested in accordance with ASTM E84.
- K. Pressure Transducers and Transmitters: Provide electronic pressure transmitters of variable capacitance type with stainless steel diaphragm and sensor body, vibration and corrosion-resistant, and weather-resistant for outdoor installations. Suitable for measurement of static or differential pressure with conversion to proportional electrical output.
- L. Current Sensors: Provide analog type current sensors to provide actual current draw for each motor. The high/low alarm limits, setpoint, etc. shall be user defined and adjustable.
- M. Humidity Sensors: Sensors shall have an accuracy of \pm 5% over a range of 20% to 95% RH.
- N. Water Flow Switches: Provide water flow switches of stainless steel or bronze paddle types. Provide pressureflow switches of bellows actuated mercury type or snap-acting type, with appropriate scale range and differential adjustment for service indicated.
- O. System Accuracy:
 - 1. The system shall maintain an end-to-end accuracy for one year from sensor to diagnostic display the following applications.
 - a. Space temperature in range of 50-85°F: within plus or minus 0.5°F.
 - b. Duct temperature in range of 40-140°F: within plus or minus 0.5°F.
 - c. Outside air (OA) temperature in range of minus 40-130°F: within plus or minus 1.0°F.
 - d. Water temperature in range of 30-100°F: plus or minus 0.5°F; in range of 100-300°F: within plus or minus 1.0°F.
 - e. Pressure: Within plus or minus 2.0 percent of range.
- P. Environmental Conditions: Furnish equipment designed to operate under ambient environmental conditions of 35-120°F dry bulb and 10 to 95 percent relative humidity. Furnish sensors and control elements designed to operate under the ambient environmental temperature, pressure, humidity, and vibration conditions specified or normally encountered for the installed location.
- Q. Power Line Surge Protection: Protect equipment power supplies from power line surges.
- R. Grounding Protection: Protect equipment from any ground fault by providing special grounding as required to prevent equipment failure under any kind of ground fault.
- S. Control Relays: Control relay contacts shall be rated for 150% of the loading application, with self-wiping, snapacting Form C contracts, enclosed in dustproof enclosure. Relays shall have a minimum life span rating of 100,000 electrical cycles and 10,000,000 mechanical cycles. Relays shall be equipped with coil transient suppression devices. Provide control relays for all 120/1-volt motors not provided with a motor starter with auxiliary contacts.
- T. Control Panels: Provide control panels with suitable brackets for wall or floor mounting, for each supply fan and miscellaneous control systems. Locate panel adjacent to systems served.
 - 1. Provide steel cabinets as required to contain temperature controllers, relays, switches, and similar devices, except limit controllers and other devices excluded in sequence of operations. Fabricate panels of 14-ga. furniture-quality steel, or 6063-T5 extruded aluminum alloy, totally enclosed, with hinged doors and keyed lock, with manufacturer's standard shop-painted finish and color. Provide UL-listed cabinets for use with line voltage devices.

- 2. Panel Mounted Equipment: Include temperature controllers, relays and automatic switches, except exclude low-temperature protection thermostats and other devices excluded in sequence of operation. Fasten devices with adjustments accessible through front of panels.
- 3. Door-Mounted Equipment: Flush-mount (on hinged door) manual switches, including damper "minimumoff" positioning switches, "manual-automatic" switches, and dial thermometers.
- U. Fault-Tolerance: Select components to operate over a wide range of supply voltage and frequency, with static, transient and short-circuit protection on all inputs and outputs. Protect communication lines against incorrect wiring, static transients and induced magnetic interference. Provide AC coupled devices for connection to communication network to limit time-outs.
- V. Carbon Dioxide Sensor: Infrared sensors capable of measuring CO₂ over a range of 0-2000 ppm. Sensor accuracy shall be ±75 ppm, and repeatability shall be ±20 ppm, over an operating temperature range of 0°C to 50°C. Provide with 0-10VAC or 4-20mA analog output for connection to the Building Automation System. Provide with Duct inlet and outlet ports, filter tubing, and hardware. Provide with LCD display option.
- W. Air Flow Measuring Stations (Duct Applications): Provide air flow measuring stations of the capacity and configuration as indicated on the drawings. The air flow stations shall be vortex shedding technology as manufactured by Ebtron. Provide sensors in accordance with manufacturer recommendation for the duct cross-sectional area and flow range. Airflow stations shall be calibrated such that the design face velocity utilizes the full range of the device. Thermal dispersion airflow stations may be utilized within intake ductwork at rooftop air handling unit applications, provided that the installation complies with the manufacturer's written guidelines. See Division 25 for BACnet Interface Device requirements. Provide the following:
 - 1. 24 volt transducer for 4-20 mA output.
 - 2. 3% accuracy over an airflow velocity range of 350 to 8500 fpm.
 - 3. Sensors of a quantity and configuration recommended by the manufacturer mounted on galvanized steel supports within the airstream.
 - 4. See Division 25 for BACnet Interface Device requirements. Device shall be a BACnet MS/TP Device networked by Division 25.
- X. Inline Magnetic Flowmeter (Pipe Insertion Type):
 - 1. Manufacturer: Provide Onicon F3500 series or Omega FMG900 series.
 - 2. Description: Inline microprocessor-based type for insertion within the pipe system and measuring flow directly in gallons per minute.
 - 3. Construction: Type 316 stainless steel electrodes.
 - 4. Ratings: 200 psig minimum pressure and 32°F to 200°F temperature.
 - 5. Transmitter: Wall mounted transmitter with NEMA 4X enclosure and minimum 40 feet of cable. Provide display with visual instantaneous rate of flow in gpm. Provide with integral transformer.
 - 6. Accuracy: 1.0% of flow rate from 2-33 feet per second. Meter shall read a minimum of 85 gpm for a 6" size, and 145 gpm for an 8" size.
 - 7. Communications: Provide analog output with 4-20mA signal for communication with the Building Automation System.
 - 8. Grounding Rings: Provide with grounding rings to ensure accuracy.
 - 9. Installation: Assemble and install and wire flow measuring elements and flow meter per manufacturer's written instructions. Install flow meter elements with minimum straight lengths of pipe upstream and downstream of element. Provide calibration and start-up of flow meters. Mount centered on pipe with minimum 1-inch diameter hole and manufacturer's recommended installation components.
 - 10. See Division 25 for BACnet Interface Device requirements. Device shall be a BACnet MS/TP Device networked by Division 25. See Division 25 for BACnet Interface Device requirements.
- Y. Dual Turbine Btu Meter:
 - 1. Manufacturer: Onicon, Rosemount, Omega, Sparling or approved equal.
 - 2. Description: Turbine, microprocessor-based type for insertion mounting and measuring flow directly in

gallons per minute and energy in Btu.

- 3. Construction: 316 stainless steel wetted components.
- 4. Ratings: 150 psig minimum pressure and -40°F to 180°F temperature.
- 5. Transmitter: Remote wall mounted flow display with NEMA 4X enclosure and minimum 40 feet of cable. Provide display with visual instantaneous rate of flow in gpm and Btu. Provide with integral transformer.
- 6. Accuracy: 1% of flow rate from 3-30 feet per second. Meter shall read a minimum of 15 gpm for a 6" size, and 26 gpm for an 8" size.
- 7. Communications: Provide analog output with 4-20mA signal for communication with the Building Automation System.
- 8. Installation: Assemble and install and wire flow measuring elements and Btu meter per manufacturer's written instructions. Install flow meter elements with minimum straight lengths of pipe upstream and downstream of element. Provide calibration and start-up Btu meters.
- 9. See Division 25 for BACnet Interface Device requirements. Device shall be a BACnet MS/TP Device networked by Division 25.

PART 3: EXECUTION

3.01 INSPECTION

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 a manner acceptable to the Installer.

3.02 INSTALLATION OF BUILDING AUTOMATION SYSTEMS

- A. Install Building Automation Systems as indicated, in accordance with system manufacturer's written instructions, and with recognized industry practices, to ensure that energy management and control equipment complies with requirements. Comply with requirements of NEC, and applicable portions of NECA's "Standard of Installation" pertaining to general electrical installation practices. Mount controllers at convenient locations and heights.
- B. Coordinate with other electrical work, including power distribution and equipment, as necessary to interface installation of energy management and control equipment work with other work.
- C. Control Wiring: The term "control wiring" is defined to include providing BAS manufacturer-approved wiring, conduit and miscellaneous materials as required for mounting and connecting control devices. Conceal wiring, except in mechanical rooms and areas where other conduit and piping are exposed. Provide plenum rated multi-conductor instrument harness (bundle) in place of single conductors where number of conductors can be run along common path. Fasten flexible conductors bridging cabinets and doors, neatly along hinge side, and protect against abrasion. Tie and support conductors neatly. Control wiring shall be plenum rated. Tees or wye taps in the communication network are not permitted.
- D. Number-code and color-code conductors, excluding those used for local individual room controls, appropriately for future identification and servicing of control system. Label ends of all conductors in control cabinets with 3M tape indicating control device.
- E. Install electrical terminations in UL approved, vented panel enclosures. Locate panels in spaces designated for use as electrical or mechanical equipment rooms. Panels shall be located to provide adequate access and clearance for servicing.
- F. All control transformers shall be located in mechanical rooms, janitor closets, or electrical rooms exposed to view. All transformers shall be clearly labeled with the systems it serves.

- G. Installation Requirements for Wall Mounted Temperature Sensors: Temperature sensors shown on the drawings are approximate locations and indicate associated equipment for bidding purposes. Coordinate the exact locations with other trades to include electrical or technology components, casework, marker boards, or other building elements and notify the engineer of any conflicts prior to rough-in such that adjustments can be made at no additional cost to the Owner.
 - 1. Mounting heights (as measured to center line of J-box):
 - a. Non-Adjustable: 5'-0" AFF
 - b. Adjustable: 3'-10" AFF
 - 2. Pre-installation conference: Shall be held prior to commencement of field installation and shall be coordinated by the BAS contractor and include the engineer and Owner's representative. The agenda shall include at a minimum the following:
 - a. Review product samples and typical locations.
 - b. Sensor features to include field adjustments and custom program features.
 - c. Typical mounting heights and locations.
 - d. Coordination issues with the work of other trades.
 - 3. Additional requirements:
 - a. Seal all holes in the junction box such that air within the wall cavity cannot flow into the junction box.
 - b. Provide insulation in the junction box behind the space temperature sensor. Insulation for sensors mounted at interior walls shall be 1/4-inch thick minimum. Insulation for sensors mounted at exterior walls shall be 1-1/2-inches thick minimum.
 - c. Provide protective guards for wall mounted adjustable space temperature sensors that are exposed in gyms and similar spaces at risk of vandalism.
 - d. Label each temperature sensor with the equipment tag number of the equipment it serves.
- H. Installation Requirements for Control Valves: Controls valves will be installed by another DIV 23 section. Coordinate delivery of controls valves to accommodate the construction schedule.
 - 1. Pre-installation conference: Shall be held prior to commencement of field installation and shall be coordinated by the BAS contractor and include the piping contractor, commissioning agent, engineer, and Owner's representative. The agenda for the meeting shall include at a minimum the following:
 - a. Review of submittals and control valve orientation.
 - b. Review of control valve and equipment type.
 - c. Sequence of construction, responsibilities and schedule for subsequent operations.
 - d. Wiring and testing of installed control valve.
 - e. System start-up procedure, including flushing of hydronic system.
- I. Reset Limit Controls: Install manual-reset limit controls to be independent of power controllers.
- J. Unit-Mounted Equipment: Where control devices are indicated to be unit-mounted, ship relays, switches, etc. to unit manufacturer for mounting and wiring at factory.
- K. Grounding: Provide tight equipment grounding connections, sufficiently tight to assure permanent and effective ground, for Building Automation Systems as indicated.
- L. Network Area Controllers and Network Switches shall be installed within IT rooms. Refer to Electrical drawings for IT room locations. Coordinate with the Owner's technologies group if equipment will be rack-mounted and required network connection location.

- M. All system settings shall conform to the Owner's protocol, including the following. Coordinate with the Owner's IT group and verify settings prior to starting field work.
 - 1. Owner's IP addresses
 - 2. Local UDP
 - 3. Ethernet network
 - 4. PTP net
 - 5. Instance range
 - 6. Display range

N. See Division 25 for Installation Requirements for all devices provided in 23 09 00.

3.03 CONTROL VALVE FAIL POSITION

A. Control valves and actuators shall be provided and configured to the fail position indicated on the following chart.

Actuator Application	Pneumatic Actuators		Electric Actuators	
	System Shutdown	Loss of Air	System Shutdown	Loss of Electricity
Dampers				
Outdoor Air	Closes	Closes	Closes	Closes
Relief Air	Closes	Closes	Closes	Closes
Return Air	Opens	Opens	Opens	Opens (1)
VAV Boxes	Stays Same	Opens	Stays Same	Stays Same
Heat Recovery Wheel Face	Stays Same	Open	Stays Same	Open
Heat Recovery Wheel Bypass	Stays Same	Close	Stays Same	Close
Valves				
AHU Chilled Water	Closes	Opens	Closes	Stays Same
AHU Hot Water	See Sequence	Opens	See Sequence	Stays Same
Terminal reheat	Closes	Opens	Closes	Stays Same
Hydronic system bypass valve	Opens	Opens	Opens	Opens
Other hot water	Closes	Opens	Closes	Stays Same
Pre-heat in OA below 35 Deg F	See Sequence	Opens	See Sequence	Opens
Pre-heat in OA above 35 Deg F	See Sequence	Opens	See Sequence	Opens

Notes:

1. Return air dampers need no springs if the associated fan is delayed upon start-up to allow the RA damper to properly position to assure that the fan does not start with both the RA and OA dampers closed.

3.04 PROJECT SCHEDULING

- A. Provide a detailed critical path schedule within 14 days of the Owner's acceptance of the General Contractor's or Construction Manager's master schedule. The critical path schedule shall incorporate the project phasing plans, and identify all equipment start-up dates. The equipment start-up dates shall be planned such that there is an adequate period of time to complete the quality control requirements and associate self-performed functional performance testing. Coordinate any specific requirements of other trades, such as power wiring, with the General Contractor or construction manager such that the master schedule incorporates these requirements of other subcontractors. The schedule shall prove a methodology to complete all work prior to Substantial Completion.
- B. The critical path schedule shall include at a minimum the following elements.
 - 1. Start and end dates for work in each phase established on the master schedule.
 - 2. Delivery of submittal documents.
 - 3. Delivery of control components to other trades such as valves and dampers.

- 4. On-site installation of control wiring, controllers, and other control components.
- 5. Start-up dates for each piece of equipment.
- 6. Functional performance tests for each phase of construction and each piece of equipment.
- 7. Delivery of all Quality Control documents.
- 8. Start date for Owner's testing agent for each phase and each piece of equipment.
- 9. Substantial Completion date.

3.05 QUALITY CONTROL

- A. Upon completion of installation of system hardware and software and after circuitry has been energized, demonstrate capability and compliance of system with requirements. All testing work shall be self performed and completed by the installer and appropriate subcontractors. Where possible, correct malfunctioning units at site, then re-test to demonstrate compliance; otherwise remove and replace with new units, and proceed with re-testing.
 - 1. Functional Performance Tests: Completion and documentation of all functional performance tests are required as a condition of substantial completion. Provide written notification to the Owner and Engineer including a copy of all testing documents that the systems are ready for the Owner's independent testing agent to begin testing. The functional performance tests shall be in checklist form and include the initials of the assigned tester and the pass date of each item to be tested. The checklists shall include but not be limited to the following:
 - a. Visual inspection verifying the installation of all control components and wiring is complete.
 - b. Calibration of all analog sensing devices.
 - c. Conductance tests of all communication and network wiring.
 - d. Visual crosscheck of each control point by making a comparison between the command and field-controlled device.
 - e. Verification of loss of power and control failure modes for each control device.
 - f. Verification of alarm notifications on the system front end as required in the control sequences.
 - g. A checklist of deficiencies that require corrective work by other trades and an anticipated date for completion.
 - 2. Owner's Testing: Once the functional performance test is submitted, the Owner's functional performance testing/commissioning agent will re-verify performance of the system meeting the requirements of the State Energy Code. For tests that fail, the controls contractor will be responsible to reimburse the Owner for the costs of the failed tests, or for any delays the tester endures due to the work being incomplete. The costs for re-testing will be paid for by the Contractor through deduct charge. Provide assistance and technical support as required to the Owner testing agent to accomplish all functional performance testing and system validation testing.
 - 3. Trend Data: Upon initial start-up of each system, provide trend data for all control and monitoring points. Coordinate with the Owner's Test Agent to transmit all requested data necessary to troubleshoot system. Upon completion of the project, coordinate with the Owner to remove any unnecessary point trends.

3.06 GRAPHICAL USER INTERFACE

- A. Provide a sample of each graphic intended for the front end user interface for review and approval by the Engineer and Owner's representative prior to final installation. The graphic must illustrate the following for review.
 - 1. Intended procedure for navigating between graphics.
 - 2. Sensor and control signal information available.
 - 3. Mode of operation status, and safety information available.

- 4. Operator override procedures.
- 5. Room number and equipment designations.
- B. Update final graphics with Owner requested revisions to room name and number identification and equipment identifications. Allocate time for technicians to update graphics and associated engineering drawing and as-built submittals after final installation of system software. The work shall be scheduled to occur prior to substantial completion.
- C. See Division 25 for graphical user interface requirements.

3.07 DEMONSTRATION AND TRAINING

- A. Provide demonstration and training for Owner's representative in accordance with Division 1 specification section 01 79 00.
- B. Building Operating Personnel Training: Train Owner's building personnel in procedures for starting-up, testing and operating Building Automation System equipment. In addition, train building personnel to maintain software, that they are capable of initiating changes to computer programs including addition and deletion of points.
- C. Provide competent instructors to give full instruction to designated personnel in the adjustment, operation and maintenance of the system installed rather than a general training course. Instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach. All training shall be held during normal work hours of 8:00 a.m. to 4:30 p.m. weekdays as follows:
 - 1. Provide 40 hours of training for owner's operating personnel. Training shall include:
 - a. Explanation of drawings, operations and maintenance manuals.
 - b. Walk-thru of the job to locate control components.
 - c. Operator workstation and peripherals and operation/functions.
 - d. Operator control functions, including graphic generation and field panel programming
 - e. Operation of portable operator's terminal.
 - f. Explanation of adjustment, calibration and replacement procedures.
 - 2. Provide additional 20 hours of training to be executed each quarter for a period of one year from final completion of the project, for a total of 80 additional hours for the year.
 - 3. Technical support staff must be made available to discuss problems as they arise, at no additional cost to the Owner.
 - 4. If additional such training is required by the Owner, it will be contracted at a later date. Provide description of available local and factory customer training.
 - 5. See Division 25 for additional training requirements.

3.08 ADJUSTING AND CLEANING

- A. Start-Up: Start-up, test, and adjust direct digital electronic control systems in presence of manufacturer's authorized representative. Demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
- B. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.
- C. Final Adjustment: After completion of installation, adjust controllers, sensors and similar equipment provided as work of this section.
 - 1. Final adjustment shall be performed by specially trained personnel in direct employ of manufacturer of primary temperature control system.

3.09 SIGNAGE

- B. Provide an engraved plastic laminate sign at all push buttons in occupied spaces to identify the function of the button. Coordinate exact language of each sign with the Owner's representative. Refer to specification section 23 05 53 for sign requirements.
- C. At each room temperature sensor, provide a sticker label that identifies the equipment controlled. Font shall be Avalon, ¹/₄" height, and black in color on a transparent background.

3.10 CLOSEOUT PROCEDURES CONTROL SEQUENCES AND POINTS SCHEDULES

- A. Every connected analog output (AO), analog input (AI), digital output (DO), and digital input (DI) represents a "point" where referred to in this specification. Refer to Specification Section 23 09 93 for specific control sequences and for complete listing of these points. Each analog output shall have its own distinct control loop. All analog points shall be adjustable through the BAS
- B. Each air handling unit, exhaust fan, unit heater, or other equipment indicated to be controlled by a time clock schedule through the BAS shall be capable of being individually programmed for its own schedule of operation. Review time of day scheduling for equipment with the Owner's representative. Modify the equipment schedules as necessary to group equipment together on a single schedule as desired to more easily facilitate changing schedules in the building. Provide a single global holiday schedule for all equipment within the building.
- C. See Division 25 for startup and commissioning requirements.

END OF SECTION 23 09 00

SECTION 23 09 50

VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1: GENERAL

1.01 SUMMARY

- A. This Section includes solid-state, PWM, VFCs for speed control of three-phase, squirrel-cage induction motors.
- B. Related Sections:
 - 1. Section 25 20 23.09.50 Integrated Automation BACnet Interface Device (Gateway/Native BACnet Devices) Variable Frequency Motor Controller (All Types).
 - 2. Section 25 00 13 Integrated Automation General Requirements All Trades Work Responsibilities.
 - 3. Division 25 Schedule 3 BACnet Single Line Diagram and Responsibility Matrix (Applies to all Trades).

1.02 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. VFC: Variable frequency controller.

1.03 SUBMITTALS

- A. Product Data: For each type of VFC. Include dimensions, mounting arrangements, location for conduit entries, shipping and operating weights, and manufacturer's technical data on features, performance, electrical ratings, characteristics, and finishes.
- B. Shop Drawings: For each VFC.
 - 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Each installed unit's type and details.
 - b. Nameplate legends.
 - c. Short-circuit current rating of integrated unit.
 - d. Listed and labeled for series rating of overcurrent protective devices in combination controllers by an NRTL acceptable to authorities having jurisdiction.
 - e. Features, characteristics, ratings, and factory settings of each motor-control center unit.

- 2. Wiring Diagrams: Power, signal, and control wiring for VFCs. Provide schematic wiring diagram for each type of VFC.
- C. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around VFCs where pipe and ducts are prohibited. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.
- D. Qualification Data: For manufacturer and testing agency.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For VFCs, all installed devices, and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Routine maintenance requirements for VFCs and all installed components.
 - 2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
- G. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.
- H. Include the BACnet Interface Device with Submittal showing proprietary points listed in 25 20 23.09.50 are mapped to BACnet Object Types. Failure to do so will result in automatic rejection of the Submittal.

1.04 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. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- C. Source Limitations: Obtain VFCs of a single type through one source from a single manufacturer.
- D. 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.
- E. Comply with NFPA 70.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver VFCs in shipping splits of lengths that can be moved past obstructions in delivery path as indicated.
- B. Store VFCs indoors in clean, dry space with uniform temperature to prevent condensation. Protect VFCs from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- C. If stored in areas subject to weather, cover VFCs to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

1.06 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.
 - 2. Humidity: Less than 90 percent (noncondensing).
 - 3. Altitude: Not exceeding 3300 feet.

1.07 COORDINATION

- A. Coordinate layout and installation of VFCs 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 size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."
- C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."
- D. Coordinate features of VFCs, installed units, and accessory devices with pilot devices and control circuits to which they connect.
- E. Coordinate features, accessories, and functions of each VFC and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.08 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Spare Fuses: Furnish one spare for every five installed, but no fewer than one set of three of each type and rating.

PART 2: PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ABB Power Distribution, Inc.; ABB Control, Inc. Subsidiary.
 - 2. Danfoss Inc.; Danfoss Electronic Drives Div.
 - 3. Yaskawa
 - 4. Square D, Schneider Electric

2.02 VARIABLE FREQUENCY CONTROLLERS

- A. General: Provide variable frequency controllers as indicated on the drawings and as required to accomplish the control intent as described in Division 23 Section 23 09 93 "BAS Sequence of Operations."
- B. Description: NEMA ICS 2, IGBT, PWM, VFC; 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.

- C. 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.
- D. Output Rating: 3-phase; 6 to 60 Hz, with voltage proportional to frequency throughout voltage range.
- E. Unit Operating Requirements:
 - 1. Input ac voltage tolerance of 208 V, plus or minus 5 or 380 to 500 V, plus or minus 10 percent as required to match motor horsepower.
 - 2. Input frequency tolerance of 50/60 Hz, plus or minus 6 percent.
 - 3. Minimum Efficiency: 96 percent at 60 Hz, full load.
 - 4. Minimum Displacement Primary-Side Power Factor: 96 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.
- F. Harmonic Voltage Distortion:
 - 1. The inverter output waveform shall be an RMS value, including voltage harmonics, not exceeding 1.05 fundamental at all normal operating speeds. Limit contribution of variable speed control 5th, 7th or 9th harmonic voltage to the electrical distribution system not beyond these limits.
- G. 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.
- H. Internal Adjustability Capabilities:
 - 1. Minimum Speed: 5 to 25 percent of maximum rpm.
 - 2. Maximum Speed: 80 to 100 percent of maximum rpm.
 - 3. Acceleration: 2 to a minimum of 22 seconds.
 - 4. Deceleration: 2 to a minimum of 22 seconds.
 - 5. Current Limit: 50 to a minimum of 110 percent of maximum rating.
- I. 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 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.
- J. 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 autospeed 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.
- K. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped.
- L. 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.
- M. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
- N. Status Lights: Door-mounted LED indicators shall indicate the following conditions:
 - 1. Power on.
 - 2. Run.
 - 3. Overvoltage.
 - 4. Line fault.
 - 5. Overcurrent.
 - 6. External fault.
- O. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual speed control potentiometer and elapsed time meter.
- P. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:
 - 1. Output frequency (Hz).
 - 2. Motor speed (rpm).
 - 3. Motor status (running, stop, fault).
 - 4. Motor current (amperes).
 - 5. Motor torque (percent).
 - 6. Fault or alarming status (code).
 - 7. PID feedback signal (percent).
 - 8. DC-link voltage (VDC).
 - 9. Set-point frequency (Hz).
 - 10. Motor output voltage (V).
- Q. 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.
- e. RS485.
- f. Keypad display for local hand operation.
- 3. Output Signal Interface:
 - a. A minimum of 1 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 2 dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
 - a. Motor running.
 - b. Set-point speed reached.
 - c. Fault and warning indication (over temperature or over current).
 - d. PID high- or low-speed limits reached.
- R. Communications: Provide an ANSI/ASHRAE standard 135-2001 BACnet protocol interface allowing VFC to be used with an external system within a multidrop LAN configuration. Interface shall allow all parameter settings of VFC to be programmed via BMS control. Provide capability for VFC to retain these settings within the nonvolatile memory.
- S. Integral Input Disconnecting Means: NEMA KS 1, nonfusible switch, with pad-lockable, door-mounted handle mechanism.
 - 1. Disconnect Rating: Not less than 115 percent of VFC input current rating.
- T. DVDT Filter: Provide a DVDT Filter on the VFC when the drive is located more than fifty feet from the motor. Refer to Drawings for exact locations.

2.03 BACnet INTERFACE DEVICES

A. Provide BACnet Interface Devices for each Variable Frequency Motor Controller so that the units are presented as a series of AV, BV and MSV BACnet objects. See 25 20 23.09.50 for the list of objects that must be supported. This list is the minimum acceptable.

2.04 ENCLOSURES

A. NEMA 250, Type 1.

2.05 ACCESSORIES

- A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.
- B. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.
- C. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.
- D. Control Relays: Auxiliary and adjustable time-delay relays.

- E. Standard Displays:
 - 1. Output frequency (Hz).
 - 2. Set-point frequency (Hz).
 - 3. Motor current (amperes).
 - 4. DC-link voltage (VDC).
 - 5. Motor torque (percent).
 - 6. Motor speed (rpm).
 - 7. Motor output voltage (V).
- F. Historical Logging Information and Displays:
 - 1. Real-time clock with current time and date.
 - 2. Running log of total power versus time.
 - 3. Total run time.
 - 4. Fault log, maintaining last four faults with time and date stamp for each.
- G. Provide drive with an electronic bypass.

2.06 FACTORY FINISHES

A. Finish: Manufacturer's standard color paint applied to factory-assembled and -tested VFCs before shipping.

PART 3: EXECUTION

3.01 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFCs for compliance with requirements, installation tolerances, and other conditions affecting performance.

3.02 APPLICATIONS

- A. Select features of each VFC 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 controlled.

3.03 INSTALLATION

A. Variable frequency motor controllers will be installed by the Electrical Contractor. Coordinate equipment delivery schedule and equipment installation requirements with the Electrical Contractor.

3.04 INSTALLATION OF BACnet INTERFACE DEVICES

- A. See the Division 25 Responsibility Matrix for the execution responsibilities for Equipment Supplier, Controls and Electrical Subcontractor.
- B. The supplier is responsible for supplying and installing the BACnet Interface Device.
- C. Electrical is responsible for power and any control wiring if the device does not have a single point of connection.
- D. Division 25 is responsible for communicating with the BACnet Interface Device using BACnet objects and services to access this data and for mapping the BACnet objects from the device(s) in this Specification Section to the BACnet Object Integration Device to create graphics, reports, trends, alarms, schedules and other requirements specified in Division 25. Division 25 is only responsible for communicating with the BACnet Interface Device using BACnet objects and services this data.

E. This BACnet Interface Device is a BACnet MS/TP device. See Division 25 for networking responsibilities.

3.05 IDENTIFICATION

- A. Identify VFCs, components, and control wiring according to Division 23 Section "Identification for HVAC Piping and Equipment."
- B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

3.06 CONTROL WIRING INSTALLATION

- A. Install wiring between VFCs and remote devices according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- B. Bundle, train, and support wiring in enclosures.

3.07 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:
 - 1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
 - 2. Assist in field testing of equipment including pretesting and adjusting of solid-state controllers.
 - 3. Report results in writing.
- C. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:
- D. Perform the following field tests and inspections and prepare test reports:
 - 1. Perform each electrical test and visual and mechanical inspection. Certify compliance with test parameters.
 - 2. Perform shaft arc testing.
 - 3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- E. Engage a factory authorized service representative to perform and/or assist with integration of equipment with the Building Automation System as part of the commissioning process. This shall be a separate, second visit at a different date than startup.

3.08 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.09 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate and maintain VFDs. Refer to Division 01 Section "Demonstration and Training."
 - 1. Required Time: 1 hour.
- B. Refer to 25 08 00, 25 08 01 and 25 20 23.09.50 for start-up, commissioning and training requirements for the BACnet Interface Devices provided in this Specification Section.

END OF SECTION 23 09 50

SECTION 23 21 23

HYDRONIC PUMPS

PART 1: GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Separately coupled, horizontal, in-line centrifugal pumps.
 - 2. Separately coupled, base-mounted, end-suction centrifugal pumps.

1.02 DEFINITIONS

- A. Buna-N: Nitrile rubber.
- B. EPT: Ethylene propylene terpolymer.

1.03 SUBMITTALS

- A. Product Data: Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.
- B. Shop Drawings: Show pump layout and connections. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.
- D. Include the BACnet Interface Device with Submittal showing proprietary points listed in 25 20 23.21.23 are mapped to BACnet Object Types. Failure to do so will result in automatic rejection of the Submittal.

1.04 QUALITY ASSURANCE

- A. Source Limitations: Obtain hydronic pumps through one source from a single manufacturer.
- 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. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.
- B. Store pumps in dry location.
- C. Retain protective covers for flanges and protective coatings during storage
- D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

E. Comply with pump manufacturer's written rigging instructions.

1.06 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.07 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Mechanical Seals: One mechanical seal for each pump.

1.08 RELATED SECTIONS

- A. Section 25 20 23.21.23 Integrated Automation BACnet Interface Device (Gateway/Native BACnet Devices) Hydronic Pumps with Variable Frequency Drives (All Types).
- B. Section 25 00 13 Integrated Automation General Requirements All Trades Work Responsibilities.
- C. Division 25 Schedule 3 BACnet Single Line Diagram and Responsibility Matrix (Applies to all Trades).
- D. 25 09 23.21.23 Integrated Automation Stick Built Device Controls Hydronic Pumps Constant Speed (All Types).
 - 1. Stick Built Device Controls" means that Division 25 shall supply and/or install controls for this device. See the above referenced Division 25 section and Responsibility Matrix for Work responsibilities.

PART 2: PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
 - 1. Inline Pumps
 - a. Bell & Gossett; Div. of ITT Industries.
 - b. Taco, Inc.
 - 2. Base Mounted Pumps
 - a. Bell & Gossett; Div. of ITT Industries.
 - b. Taco, Inc.

2.02 SEPARATELY COUPLED, HORIZONTAL, IN-LINE CENTRIFUGAL PUMPS

- A. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally. Rate pump for 175-psig minimum working pressure and a continuous water temperature of 225 deg F.
- B. Pump Construction:
 - 1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, and threaded companion-flange connections.

- 2. Impeller: Stainless steel or bronze as may be necessary to Department of Energy Index (PEI) energy efficiency requirements; The impeller shall be statically and dynamically balanced, and keyed to shaft. Trim impeller to match specified performance.
- 3. Pump Shaft: Stainless steel.
- 4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.
- 5. Pump Bearings: Permanently lubricated ball bearings.
- C. Shaft Coupling: Molded rubber insert with interlocking spider capable of absorbing vibration.
- D. Pump Efficiency: Shall comply with the Department of Energy Pump Energy Index (PEI). Each pump shall be provided with a permanent name plate stating PEI compliance.
- E. Motor: Single speed, with permanently lubricated ball bearings, unless otherwise indicated; and resiliently mounted to pump casing. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment", including, but not limited to, efficiency ad power factor correction requirements.

2.03 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

- A. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal. Rate pump for 175-psig minimum working pressure and a continuous water temperature of 225 deg F.
- B. Pump Construction:
 - 1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and flanged connections.
 - 2. Impeller: Stainless steel or bronze as may be necessary to Department of Energy Index (PEI) energy efficiency requirements; The impeller shall be statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
 - 3. Pump Shaft: Stainless steel.
 - 4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket.
 - 5. Packing Seal: Stuffing box, with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
 - 6. Pump Bearings: Grease-lubricated ball bearings contained in cast-iron housing with grease fittings.
- C. Shaft Coupling: Molded rubber insert and interlocking spider capable of absorbing vibration. Provide EPDM coupling sleeve for variable-speed applications.
- D. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.
- E. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.
- F. Pump Efficiency: Shall comply with the Department of Energy Pump Energy Index (PEI). Each pump shall be provided with a permanent name plate stating PEI compliance.

G. Motor: Single speed, with grease-lubricated ball bearings, unless otherwise indicated; secured to mounting frame, with adjustable alignment. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment", including, but not limited to, efficiency and power factor correction requirements, and 25 20 23.09.50 (VFDs).

2.04 PUMP SPECIALTY FITTINGS

- A. Suction Diffuser: Angle pattern, 175-psig pressure rating, cast-iron body and end cap, pump-inlet fitting; with bronze startup and bronze or stainless-steel permanent strainers; bronze or stainless-steel straightening vanes; drain plug; and factory-fabricated support.
- B. Triple-Duty Valve: Angle or straight pattern, 175-psig pressure rating, cast-iron body, pump-discharge fitting; with drain plug and bronze-fitted shutoff, balancing, and check valve features. Brass gage ports with integral check valve, and orifice for flow measurement.

2.05 BACnet INTERFACE DEVICES"

- A. There is no BACnet Interface Device for the equipment specified in this Specification Section if the pump motor is not controlled by a Variable Frequency Motor Controller.
- B. The controls for the devices specified in this section are "Stick Built Device Controls" that are supplied installed by Division 25 if the pump motor is not controlled by a Variable Frequency Motor Controller.
- C. If the pump is controlled by a Variable Frequency Motor Controller, provide BACnet Interface Devices for each Variable Frequency Motor Controller so that the units are presented as a series of AV, BV and MSV BACnet objects. See 25 20 23.09.50 for the list of objects that must be supported. This list is the minimum acceptable.

PART 3: EXECUTION

3.01 EXAMINATION

- A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of work.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
- C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 CONCRETE BASES

A. Cast-in-place concrete materials and placement requirements are specified in Division 03.

3.03 PUMP INSTALLATION

- A. Comply with manufacturer's written instructions and guidelines.
- B. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.
- C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

- D. Set base-mounted pumps on concrete foundation. Disconnect coupling before setting. Do not reconnect couplings until alignment procedure is complete.
 - 1. Support pump baseplate on rectangular metal blocks and shims, or on metal wedges with small taper, at points near foundation bolts to provide a gap of 3/4 to 1-1/2 inches between pump base and foundation for grouting.
 - 2. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.

E. See Division 25 for installation, commissioning requirements.

3.04 ALIGNMENT

- A. Align pump and motor shafts and piping connections after setting on foundation, grout has been set and foundation bolts have been tightened, and piping connections have been made. Align pump and motor shafts with laser alignment technique.
- B. Comply with pump and coupling manufacturers' written instructions.
- C. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.05 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.
- D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
- E. Install check valve and throttling valve on discharge side of pumps.
- F. Install suction diffuser and shutoff valve on suction side of pumps.
- G. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.
- H. Install pressure gages on pump suction and discharge, at integral pressure-gage tapping, or install single gage with multiple input selector valve.
- I. Install check valve and gate or ball valve on each condensate pump unit discharge.

3.06 STARTUP SERVICE

- A. Complete pump start-up procedures in accordance with the manufacturer's instructions and guidelines. At a minimum perform the following:
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Check piping connections for tightness.
 - 3. Clean strainers on suction piping.
 - 4. Perform the following startup checks for each pump before starting:
 - a. Verify bearing lubrication.

- b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
- c. Verify that pump is rotating in the correct direction.
- 5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
- 6. Start motor.
- 7. Open discharge valve slowly.

3.07 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate and maintain pumps. Refer to Division 01 Section "Demonstration and Training."
 - 1. Required Time: As required.
- B. Refer to 25 08 00, 25 08 01 and 25 20 23.09.50 for start-up, commissioning and training requirements for the BACnet Interface Devices provided by Division 25 for equipment specified in this Specification Section.

END OF SECTION 23 21 23

SECTION 23 34 16

AIR HANDLING

PART 1: GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Centrifugal roof ventilators.

B. Related Sections:

- 1. Section 25 09 23. 34.16 Integrated Automation Stick Built Device Controls Constant Speed Exhaust Fans (All Types). This section applies to Exhaust Fans in this Specification Section that are not controlled by VFDs.
 - a. "Stick Built Device Controls" means that Division 25 shall supply and/or install controls for this device. See the above referenced Division 25 section and Responsibility Matrix for Work responsibilities.
- Section 25 20 23.09.50 Integrated Automation BACnet Interface Device (Gateway/Native BACnet Devices) Variable Frequency Motor Controller (All Types). This section applies to Exhaust Fans in this Specification Section that are controlled by VFDs.
- 3. Section 25 00 13 Integrated Automation General Requirements All Trades Work Responsibilities.
- 4. Division 25 Schedule 3 BACnet Single Line Diagram and Responsibility Matrix (Applies to all Trades).
- 5. Section 25 20 23.34.16 Integrated Automation BACnet Interface Device (Gateway/Native BACnet Devices) HVAC Fans (Air Handling) with Variable Frequency Drives (All Types).

1.02 PERFORMANCE REQUIREMENTS

- A. Project Altitude: Base fan-performance ratings on sea level.
- B. Operating Limits: Classify according to AMCA 99.

1.03 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
 - 1. Certified fan performance curves with system operating conditions indicated.
 - 2. Certified fan sound-power ratings.
 - 3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 4. Material thickness and finishes, including color charts.
 - 5. Dampers, including housings, linkages, and operators.
 - 6. Roof curbs.
 - 7. Fan speed controllers.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Power, signal, and control wiring.

- 2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
- 3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.
- C. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Roof framing and support members relative to duct penetrations.
- D. Include the BACnet Interface Device with Submittal for exhaust fans requiring variable speed motor controllers showing proprietary points listed in 25 20 23.09.50 are mapped to BACnet Object Types. Failure to do so will result in automatic rejection of the Submittal.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.04 QUALITY ASSURANCE

- A. 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.
- B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.
- C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.
- D. UL Standard: Power ventilators shall comply with UL 705.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.
- B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.

1.06 COORDINATION

- A. Coordinate size and location of structural-steel support members.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2: PRODUCTS

2.01 CENTRIFUGAL ROOF VENTILATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Acme Engineering & Mfg. Corp.
 - 2. Aerovent; a Twin City Fan Company
 - 3. Ammerman; General Resource Corp.
 - 4. Captive Aire
 - 5. Carnes Company HVAC.
 - 6. Delhi Industries Inc.
 - 7. Greenheck.
 - 8. Loren Cook Company.
 - 9. Penn Ventilation.
 - 10. Twin City Fan and Blower Co.
- B. Description: Direct driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.
- C. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.
 - 1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.
 - 2. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.
- D. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
- E. Accessories:
 - 1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent. Provide on all direct drive fans and as noted on the drawings.
 - 2. Disconnect Switch: For single phase motors, provide nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit for three phase motors, a combination starter/disconnect will be provided by Division 26.
 - 3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
 - 4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
 - 5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
- F. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.
 - 1. Configuration: Self-flashing without a cant strip, with mounting flange or built-in raised cant and mounting flange as required for roofing type.
 - 2. Overall Height: 24 inches unless otherwise noted on plans.
 - 3. Sound Curb: Curb with sound-absorbing insulation matrix.

- 4. Pitch Mounting: Manufacture curb for roof slope.
- 5. Metal Liner: Galvanized steel.
- 6. Mounting Pedestal: Galvanized steel with removable access panel.
- 7. Vented Curb: Unlined with louvered vents in vertical sides.

2.02 MOTORS

- A. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment", including, but not limited to, efficiency ad power factor correction requirements, and 25 20 23.09.50 Variable Frequency Motor Controllers.
- B. Enclosure Type: Totally enclosed, fan cooled.
- C. Direct-Driven Units: Encase motor in housing outside of airstream, factory wired to disconnect switch located on outside of fan housing.

2.03 BACnet INTERFACE DEVICES

- A. There is no BACnet Interface Device for the equipment specified in this Specification Section if the exhaust fan motor is not controlled by a Variable Frequency Motor Controller.
- B. The controls for the devices specified in this section are "Stick Built Device Controls" that are supplied installed by Division 25 if the exhaust fan motor is not controlled by a Variable Frequency Motor Controller.
- C. If the exhaust fan is controlled by a Variable Frequency Motor Controller, provide BACnet Interface Devices for each Variable Frequency Motor Controller so that the units are presented as a series of AV, BV and MSV BACnet objects. See 25 20 23.09.50 for the list of objects that must be supported. This list is the minimum acceptable.

2.04 SOURCE QUALITY CONTROL

- A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3: EXECUTION

3.01 INSTALLATION

- A. Install power ventilators level and plumb.
- B. Support units using elastomeric mounts, restrained elastomeric mounts, spring isolators or restrained spring isolators having a static deflection of 1 inch.
- C. Secure roof-mounting fans to roof curbs with cadmium-plated hardware. Refer to Division 07 and architectural details of construction for installation of roof curbs.
- D. Install units with clearances for service and maintenance.

- E. Label units according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."
- F. There is no BACnet interface for this exhaust fan if it is a constant speed device. This is a component that is instrumented by Division 25.
- G. See 25 20 23.09.50 for BACnet requirements for an exhaust fan that is controlled by a Variable Frequency Motor Controller.

3.02 CONNECTIONS

- A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Air Duct Accessories."
- B. Install ducts adjacent to power ventilators to allow service and maintenance.
- C. Label fans according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."

3.03 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Verify that shipping, blocking, and bracing are removed.
 - 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 - 3. Verify that cleaning and adjusting are complete.
 - 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
 - 5. Adjust damper linkages for proper damper operation.
 - 6. Verify lubrication for bearings and other moving parts.
 - 7. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
 - 8. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
 - 9. Shut unit down and reconnect automatic temperature-control operators.
 - 10. Remove and replace malfunctioning units and retest as specified above.
- B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.04 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Refer to Division 23 Section "Testing, Adjusting, and Balancing " for testing, adjusting, and balancing procedures.

- C. Replace fan and motor pulleys as required to achieve design airflow.
- D. Lubricate bearings.

3.05 PROJECT CLOSEOUT

- A. Replace fan drives and sheaves as directed by the Engineer as required for systems to perform to the intended design conditions. The Contractor's bid shall include labor and materials required to replace the quantity of drives and sheaves specified in Part 1.0 "Extra Materials".
- B. Replace fan motors as directed by the Engineer as required for systems to perform to the intended design conditions. The Contractor's bid shall include all material and labor required to replace the quantity at motors, specified in Part 1.0 "Extra Materials".

3.06 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate and maintain fans. Refer to Division 01 Section "Demonstration and Training."
 - 1. Required Time: 2 hours.
- B. Refer to 25 08 00, 25 08 01 and 25 09 23.34.16 for the Stick Built controls commissioning, demonstration and training requirements for the constant speed exhaust fan equipment provided in this Specification Section.
- C. Refer to 25 08 00, 25 08 01 and 25 20 23.34.16 for the networked controls commissioning, demonstration and training requirements for the equipment controlled by a Variable Speed Motor Controller provided in this Specification Section.

END OF SECTION 23 34 16

SECTION 23 36 00

AIR TERMINAL UNITS

PART 1: GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Single-duct air terminal units.
- B. Related Sections:
 - 1. Section 25 20 23.36.00 Integrated Automation BACnet Interface Device (Gateway/Native BACnet Devices) Air Terminal Units (All Types).
 - 2. Section 25 00 13 Integrated Automation General Requirements All Trades Work Responsibilities.
 - 3. Division 25 Schedule 3 BACnet Single Line Diagram and Responsibility Matrix (Applies to all Trades).

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated, include rated capacities, furnished specialties, sound-power ratings, and accessories.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Include a schedule showing unique model designation, room location, model number, size, and accessories furnished.
 - 2. Wiring Diagrams: Power, signal, and control wiring.
- C. Coordination Drawings: Refer to requirements in Section 23 05 00.
- D. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data" include the following:
 - 1. Instructions for resetting minimum and maximum air volumes.
 - 2. Instructions for adjusting software set points.
- E. Include the BACnet Interface Device with Submittal showing proprietary points listed in 25 20 23.36.00 are mapped to BACnet Object Types. Failure to do so will result in automatic rejection of the Submittal.

1.03 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of air terminal units and are based on the specific system indicated. Refer to Division 01 Section "Substitutions and Product Options."
- 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. NFPA Compliance: Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

1.04 COORDINATION

A. Coordinate layout and installation of air terminal units and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2: PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with requirements, provide products by one of the manufacturers specified.
 - 1. Manufacturers:
 - a. Anemostat; a Mestek Company.
 - b. Carnes.
 - c. Enviro-Tec
 - d. Krueger.
 - e. METALAIRE, Inc.; Metal Industries Inc.
 - f. Nailor Industries of Texas Inc.
 - g. Price Industries.
 - h. Titus.
 - i. Trane Co. (The); Worldwide Applied Systems Group.
 - j. Tuttle & Bailey.

2.02 SINGLE-DUCT AIR TERMINAL UNITS

- A. Configuration: Volume-damper assembly inside unit casing with control components located inside a protective metal shroud.
- B. Casing: 0.034-inch steel.
 - 1. Casing Lining: Adhesive attached, 3/8-inch thick, fiber free polyolefin insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
 - 2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
 - 3. Air Outlet: S-slip and drive connections.
 - 4. Access: Removable panels for access to dampers, upstream of heating coils, and other parts requiring service, adjustment, or maintenance; with airtight gasket and quarter-turn latches.
- C. Regulator Assembly: Extruded-aluminum or galvanized-steel components; key damper blades onto shaft with nylonfitted pivot points located inside unit casing.
 - 1. Factory-calibrated and field-adjustable assembly with shaft extension for connection to externally mounted control actuator.
- D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
 - 1. Maximum Damper Leakage: ARI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.

- 2. Damper Position: Normally open.
- E. Velocity Sensor: Provide multi-point, center averaging velocity sensor.
- F. Hot-Water Heating Coil: Copper tube, mechanically expanded into aluminum-plate fins; leak tested underwater to 200 psig; and factory installed.
- G. Electronic Controls: Factory install and wire the single-duct terminal unit controller and actuator assembly as furnished by the Division 23 Building Automation System Contractor. Coordinate required devliery schedule of materials to the factory.
- H. Provide factory installed control box with removable cover for controller and actuator assembly.

2.03 BACnet INTERFACE DEVICES

- A. Provide BACnet Interface Devices for each Fan Coil Unit so that the units are presented as a series of AV, BV and MSV BACnet objects. See 25 20 23.36.00 for the list of objects that must be supported. This list is the minimum acceptable.
- B. The controls for the devices in this Specification Section are BACnet MS/TP controllers that once approved via the Submittal process, shall be sent to the Equipment Supplier's factory for factory mounting. Failure to do so will require Division 25 to field install all the controls.
- C. Division 25 is responsible for the BACnet MS/TP network communications wiring to all equipment provided in this Specification Section.

2.04 SOURCE QUALITY CONTROL

- A. Identification: Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.
- B. Verification of Performance: Rate air terminal units according to ARI 880.

PART 3: EXECUTION

3.01 INSTALLATION

A. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

3.02 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to air terminal units to allow service and maintenance.
- C. Hot-Water Piping: In addition to requirements in Division 23 Section "Hydronic Piping," connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange.
- D. Connect ducts to air terminal units according to Division 23 Section "Ductwork."
- E. Ground units with electric heating coils according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- F. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

G. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.03 INSTALLATION OF BACnet INTERFACE DEVICE

- A. See the Division 25 Responsibility Matrix for the execution responsibilities for Equipment Supplier, Controls and Electrical Subcontractor.
- B. The supplier is responsible for supplying and installing the BACnet Interface Device.
- C. Electrical is responsible for power and any control wiring if the device does not have a single point of connection.
- D. Division 25 is responsible for communicating with the BACnet Interface Device using BACnet objects and services to access this data and for mapping the BACnet objects from the device(s) in this Specification Section to the BACnet Object Integration Device to create graphics, reports, trends, alarms, schedules and other requirements specified in Division 25. Division 25 is only responsible for communicating with the BACnet Interface Device using BACnet objects and services to access this data.
- E. This BACnet Interface Device is a BACnet MS/TP device. See Division 25 for networking responsibilities.

3.04 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Remove and replace malfunctioning units and retest as specified above.

3.05 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions and do the following:
 - a. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
 - b. Verify that controls and control enclosure are accessible.
 - c. Verify that control connections are complete.
 - d. Verify that nameplate and identification tag are visible.
 - e. Verify that controls respond to inputs as specified.
- B. Engage a factory authorized service representative to perform and/or assist with integration of equipment with the Building Automation System as part of the commissioning process. This shall be a separate, second visit at a different date than startup.

3.06 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate and maintain air terminal units. Refer to Division 01 Section "Demonstration and Training."
 - 1. Required Time: 1 hour.

B. Refer to 25 08 01, 25 08 02 and 25 20 23.36.00 for start-up, commissioning and training requirement for the BACnet Interface Devices provided in this Specification Section.

END OF SECTION 23 36 00

SECTION 23 52 21

ELECTRIC BOILERS

PART 1 : GENERAL

1.01 SUMMARY

- A. This Section includes packaged, factory-fabricated and -assembled electric boilers, trim, and accessories for generating hot water.
- B. Related Sections:
 - 1. Section 25 20 23.52.21 Integrated Automation BACnet Interface Device (Gateway/Native BACnet Devices) Electric Boilers (All Types).
 - 2. Section 25 00 13 Integrated Automation General Requirements All Trades Work Responsibilities.
 - 3. Division 25 Schedule 3 BACnet Single Line Diagram and Responsibility Matrix (Applies to all Trades).

1.02 SUBMITTALS

- A. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Design calculations and vibration isolation base details, signed and sealed by a qualified professional engineer.
 - a. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
 - 2. Wiring Diagrams: Power, signal, and control wiring to be included with each boiler.
- C. Source quality-control test reports.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For boilers, components, and accessories to include in emergency, operation, and maintenance manuals.
- F. Warranty: Special warranty specified in this Section.
- G. Include the BACnet Interface Device with Submittal showing proprietary points listed in 25 20 23.52.21 are mapped to BACnet Object Types. Failure to do so will result in automatic rejection of the Submittal.
- H. Other Informational Submittals:
 - 1. ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.
 - 2. Startup service reports.

1.03 QUALITY ASSURANCE

- A. 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.
- B. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.
- C. NFPA Compliance: Design and fabricate boilers to comply with NFPA 70, "National Electrical Code," Article 424, Paragraphs G and H.
- D. UL Compliance: Test boilers for compliance with UL 834, "Heating, Water Supply, and Power Boilers--Electric." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

1.04 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.05 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace pressure vessels of boilers that fail in materials or workmanship within specified warranty period.
 - 1. Parts: One years from date of Substantial Completion for any part the equipment found to be defective in workmanship or material.
 - 2. Boiler: Five years from date of Substantial Completion for any part the pressure vessel found to be defective in workmanship or material.

PART 2 : PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Fulton
 - 2. Bryan Steam, LLC.
 - 3. Precision Boilers.

2.02 BOILER CONSTRUCTION

- A. The boiler shall be completely factory assembled as a self-contained unit. Each boiler shall be neatly finished, thoroughly tested, and properly packaged for shipping.
- B. The pressure vessel design and construction shall be in accordance with Section IV of the ASME Code for heating boilers (Section I optional for high temperature boilers). The boiler shall comply with CSD-1 code requirements and carry a UL listing (CAS/CUL approval for Canada CAN/CSA-C22.2 No. 165-92).
- C. The pressure vessel shell and heads shall be SA-53B ERW pipe or SA-516 Grade 70 plate and have the following minimum thickness (160 psig design):
 - 1. Shell: 0.313-inches.
 - 2. Head: 0.625-inches.

- D. Boiler shall be covered with a blanket type, high temperature insulation.
- E. The metal jacket shall have a primer and finish coats of paint.

2.03 BOILER DESIGN

- A. The boiler shall be a vertical design with adequate openings for access to the water side of the boiler.
- B. Boiler shall be supplied with resistance type heating elements with 321 stainless steel sheathing to ensure longer life.
- C. The heating elements shall have a watt density not to exceed 75 Watts per square inch.
- D. The water volume of the boiler shall not be less than 68 gallons.

2.04 CONTROLS

- A. Boiler safety controls shall include:
 - 1. Operating Temperature Controller for automatic start and stop of boiler operation.
 - 2. High Limit Temperature Controller with manual reset.
 - 3. PID type operating temperature controller with digital display (units with step sequencer only only).
 - 4. A probe type low water cut-off to cause a shut-down of unit should the water level drop to an unsafe level.
 - 5. Element Step Sequencer Controller for boilers 105KW (10.5HP) and above: Modulation of boiler capacity shall be by a solid state step controller capable of either fully automatic or manual operation. Step controller shall be the first on/first off type to equally exercise all heating elements. Step controller will incorporate a field adjustable timed intermittent (X seconds on, Y seconds off) cycle to minimize fluctuations in temperature.
- B. Building Automation System Interface: Factory install hardware and software to enable building management system to monitor, control, and display boiler status and alarms.
 - 1. Hardwired Points:
 - a. Monitoring: On/off status, common trouble alarm, low water level alarm.
 - b. Control: On/off operation, hot water supply temperature set-point adjustment.
 - 2. Provide with a BACnet IP gateway for communication interface with building automation system shall enable building automation system operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through building management system.
- C. BACnet interface devices:
 - 1. Provide BACnet Interface Devices for each Electric Boiler so that the units are presented as a series of AV, BV and MSV BACnet objects. See 25 20 23.52.21 for the list of objects that must be supported. This list is the minimum acceptable.
- D. All controls to be panel mounted in a NEMA Type 1 enclosure and so located on the boiler as to provide ease of servicing the boiler without disturbing the controls. Panel shall be located to prevent possible damage by

water or heat. Controls connected to water or steam shall be installed outside the main boiler control panel. All controls shall be mounted and wired according to Underwriters' Laboratories requirements.

2.05 BOILER FITTINGS AND TRIM

- A. The boiler shall be supplied with an ASME Section IV safety relief valve (Section I valve for Section I vessels). The safety relief valve size shall be in accordance with ASME code requirements and set at 160 psig for Section IV Pressure Vessels.
- B. A combination temperature/pressure gauge shall be included with the boiler.
- C. The boiler shall come set up for transporting by fork lift.
- D. Instructions for installation, operation and maintenance of the boiler shall be contained in a manual provided with each boiler.

2.06 ELECTRICAL POWER

- A. Single-Point Field Power Connection: Factory-installed and -wired switches, transformers, and electrical devices necessary shall provide a single-point field power connection to boiler.
 - 1. Field power interface shall be to fused disconnect switch.
 - 2. Interlock with door to de-energize power with door open.
- B. Supplemental internal branch circuit fuses, current limiting, rated at 200,000 amps interrupting capacity.
- C. Electrical Enclosures: NEMA 250, Type 1 enclosure with hinged door and key-locking handle.
- D. Install factory wiring outside of an enclosure in a metal raceway.
- E. Comply with NFPA 70.
 - 1. Electrical Circuits: 48 A, maximum.
- F. Connectors: Mechanical lugs bolted to copper bus bars or distribution blocks with pressure connectors.
- G. Fuses: NEMA FU 1, Class J or K5; 60 A, maximum.
- H. Contactors: 3-pole magnetic contactors, listed for 500,000 cycles at full load.
- I. Factory-wired internal control devices and heating elements.
 - 1. Wiring shall be numbered and color coded to match the wiring diagram.

2.07 SOURCE QUALITY CONTROL

- A. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.
- B. Hydrostatic Test: Factory test assembled boiler including hydrostatic test.

PART 3 : EXECUTION

3.01 EXAMINATION

- A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.
 - 1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- B. Examine mechanical spaces, including required space for element removal, for suitable conditions where boilers will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 BOILER INSTALLATION

- A. Install boilers level on concrete base. Concrete base is specified in Division 23 Section "Common Work Results for HVAC," and concrete materials and installation requirements are specified in Division 03.
- B. Assemble unit sections and parts shipped loose or unassembled for shipment purposes. Follow manufacturer's installation recommendations and instructions.
- C. Vibration Isolation: Elastomeric isolator pads with a minimum static deflection of 0.25 inch. Vibration isolation devices and installation requirements are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- D. Install electrical devices furnished with boiler but not specified to be factory mounted.

3.03 INSTALLATION OF BACnet INTERAFCE DEVICE

- A. See the Division 25 Responsibility Matrix for the execution responsibilities for Equipment Supplier, Controls and Electrical Subcontractor.
- B. The supplier is responsible for supplying and installing the BACnet Interface Device.
- C. Electrical is responsible for power and any control wiring if the device does not have a single point of connection.
- D. Division 25 is responsible for communicating with the BACnet Interface Device using BACnet objects and services to access this data and for mapping the BACnet objects from the device(s) in this Specification Section to the BACnet Object Integration Device to create graphics, reports, trends, alarms, schedules and other requirements specified in Division 25. Division 25 is only responsible for communicating with the BACnet Interface Device using BACnet objects and services to access this data.
- E. This BACnet Interface Device is a BACnet/IP device. See Division 27 for networking responsibilities.

3.04 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to boiler to allow service and maintenance.
- C. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.

- D. Install piping from safety relief valves to nearest floor drain.
- E. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.
- F. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems." And connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.05 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. Perform installation and startup checks according to manufacturer's written instructions.
 - 2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - a. Check and adjust initial operating set points and high- and low-limit safety set points of water level and water temperature.
 - b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to one visits to Project during other than normal occupancy hours for this purpose.
- E. Performance Tests:
 - 1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
 - 2. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment in order to comply.
 - 3. Perform field performance tests to determine the capacity of boilers.
 - 4. Repeat tests until results comply with requirements indicated.
 - 5. Provide analysis equipment required to determine performance.
 - 6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.
 - 7. Notify Architect in advance of test dates.
 - 8. Document test results in a report and submit to Architect.
- F. Engage a factory authorized service representative to perform and/or assist with integration of equipment with the Building Automation System as part of the commissioning process. This shall be a separate, second visit at a different date than startup.

3.06 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate and maintain electric boilers. Refer to Division 01 Section "Demonstration and Training."
 - 1. Required Time: 4 hours

B. Refer to 25 08 00, 25 08 01 and 25 20 23.52.21 for start-up, commissioning and training requirements for the BACnet Interface Devices provided in this Specification Section.

END OF SECTION 23 52 21

SECTION 23 64 30

GEOTHERMAL WATER-TO-WATER HEAT PUMPS

PART 1: GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Packaged, water-to-water scroll compressor heat pump.
- B. Related Sections:
 - 1. Section 25 20 23.64.30 Integrated Automation BACnet Interface Device (Gateway/Native BACnet Devices) Geothermal Water-to-Water Heat Pumps (All Types).
 - 2. Section 25 00 13 Integrated Automation General Requirements All Trades Work Responsibilities.
 - 3. Division 25 Schedule 3 BACnet Single Line Diagram and Responsibility Matrix (Applies to all Trades).

1.02 DEFINITIONS

- A. BAS: Building automation system.
- B. COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input using consistent units for any given set of rating conditions.
- C. EER: Energy-efficiency ratio. The ratio of the cooling capacity given in terms of Btu/h to the total power input given in terms of watts at any given set of rating conditions.
- D. IPLV: Integrated part-load value. A single-number part-load efficiency figure of merit calculated per the method defined by ARI 550/590 and referenced to ARI standard rating conditions.
- E. kW/Ton (kW/kW): The ratio of total power input of the chiller in kilowatts to the net refrigerating capacity in tons (kW) at any given set of rating conditions.
- F. NPLV: Nonstandard part-load value. A single-number part-load efficiency figure of merit calculated per the method defined by ARI 550/590 and intended for operating conditions other than ARI standard rating conditions.

1.03 PERFORMANCE REQUIREMENTS

- A. Fluid Temperature Performance:
 - 1. Minimum Operating Source-Fluid Temperature in Summer Operation: Heat Pump shall be capable of continuous operation over the entire capacity range indicated with an entering/leaving source-fluid temperature per schedule. Step capacity control is not acceptable.
 - 2. Maximum Operating Load Side Fluid Temperature in Winter Operation: Heat Pump shall be cabable of continuous operation over the entire capacity range indicated with an enterin/leaving load side fluid temperature per schedule. Step capacity control is not acceptable.
 - 3. Make factory modifications to standard heat pump design if necessary to comply with performance indicated.

1.04 SUBMITTALS

- A. Product Data: For each type of product indicated. Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.
 - 1. Performance at ARI standard conditions and at conditions indicated.
 - 2. Performance at ARI standard unloading conditions.
 - 3. Minimum evaporator flow rate.
 - 4. Minimum source flow rate.
 - 5. Refrigerant capacity of chiller.
 - 6. Oil capacity of chiller.
 - 7. Fluid capacity of evaporator.
 - 8. Characteristics of safety relief valves.
 - 9. Fluid capacity of condenser.
 - 10. Minimum entering source-fluid temperature.
 - 11. Performance at varying capacities with constant-design entering condenser-fluid temperature. Repeat performance at varying capacities for different condenser-fluid temperatures from design to minimum in 5 deg F increments.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, load distribution, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.
- C. Coordination Drawings: Floor plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
 - 1. Structural supports.
 - 2. Piping roughing-in requirements.
 - 3. Wiring roughing-in requirements, including spaces reserved for electrical equipment.
 - 4. Access requirements, including working clearances for mechanical controls and electrical equipment, and tube pull and service clearances.
- D. Certificates: For certification required in "Quality Assurance" Article.
- E. Source quality-control reports.
- F. Startup service reports.
- G. Operation and Maintenance Data: For each chiller to include in emergency, operation, and maintenance manuals.
- H. Warranty: Sample of special warranty.
- I. Include the BACnet Interface Device with Submittal showing proprietary points listed in 25 20 23.64.30 are mapped to BACnet Object Types. Failure to do so will result in automatic rejection of the Submittal.

1.05 QUALITY ASSURANCE

- A. ARI Rating: Rate heat pump performance according to requirements in ARI 550/590.
- B. ASHRAE Compliance:
 - 1. ASHRAE 15 for safety code for mechanical refrigeration.
 - 2. ASHRAE 147 for refrigerant leaks, recovery, and handling and storage requirements.
 - 3. ASHRAE 135-2004 BACnet protocol for heat pump controller.

- C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1
- D. ASME Compliance: Fabricate and label chiller to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, and include an ASME U-stamp and nameplate certifying compliance.
- E. Comply with NFPA 70.
- F. Comply with requirements of UL and UL Canada and include label by a qualified testing agency showing compliance.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Ship heat pumps from the factory fully charged with refrigerant.
- B. Ship each heat pump with a full charge of refrigerant. Charge each chiller with nitrogen if refrigerant is shipped in containers separate from chiller.
- C. Package heat pump for export shipping in totally enclosed bagging.

1.07 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.
- B. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures.
- C. Coordinate with the BAS contractor to provide control interface specified in Sections 23 09 00, 23 09 05 and 23 09 93.
- D. Coordinate with the BAS contractor, test and balance contractor, and commissioning agent for start-up, balancing and functional testing.

1.08 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of chillers that fail in materials or workmanship within specified warranty period.
 - 1. Extended warranties include, but are not limited to, the following:
 - a. Complete heat pump, including refrigerant and oil change.
 - 2. Warranty Period: Five years from date of Substantial Completion.

PART 2: PRODUCTS

2.01 GENERAL

- A. Manufacturer: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - 1. Multistack VMEII
 - 2. ClimaCool

- B. Description: Chiller/Heater shall incorporate Scroll-type compressors and consist of multiple refrigerant circuits. Each refrigerant circuit shall consist of an individual compressor, condenser, evaporator circuit, thermal expansion valve, and control system. Each circuit shall be constructed to be independent of other circuits from a refrigeration and electrical stand-point. The multi-circuit Chiller/Heater must be able to produce chilled or heated water even in the event of a failure of one or more refrigerant circuits. Circuits shall not contain more than 24(MS70X) / 12 lb. of R-410a refrigerant.
- C. System shall be configured to allow modules to run in simultaneous Dedicated Heat Recovery Chiller (DHRC)[™] mode, dominant cooling mode, and dominant heating mode. The Chiller/Heater must be capable of allowing modules to run in multiple modes at the same time to optimize efficiency.
 - 1. Simultaneous Heating and Cooling Mode Chiller/Heater assembly must be capable of varying the flow rate on the evaporator and condenser sides of the modules to maintain heating and cooling water set points simultaneously. Simultaneous loads must be satisfied with a single compression cycle and cannot use the source/sink solution as the means of energy transfer. Systems that require double compression to satisfy simultaneous loads are not acceptable.
 - Cooling Dominant Mode Chiller/Heater must be able to reject cooling dominant load to the source/sink. Cooling dominant modules must be capable of running at a lower head pressure than simultaneous modules to minimize power consumption.
 - 3. Heating Dominant Mode Chiller/Heater must be able to satisfy heating dominant load by extracting heat from the source/sink. Heating dominant modules must be capable of running at optimal suction pressure to minimize power consumption.
 - 4. Packaged System Shall Be Reversing Valve Free Design Chiller/Heater must be reversing valve free and optimize heat transfer in all control modes.
 - 5. Source/Sink Water Connections Chiller/Heater must allow geothermal loop water to enter both the evaporator and condenser side of the machine.
- D. Chiller/Heater shall be designed to operate using R-410a Refrigerant.
- E. Virtual Moveable Endcap II[™] (patent pending): The Chiller/Heater shall be designed for simultaneous variable heating and cooling capacity. VME II valve module shall contain fast-acting motorized butterfly valves that open/close on a command from the central control system. The motorized actuators shall be NEMA 4X rated with easily visible position indicators and internal thermal motor overload protection. Valves shall be fast acting type with a maximum stroke time (full closed to full open) of 30 seconds. Valve modules shall be built into pre-engineered headers and powered by the Chiller/Heaters bussbar. VME II valves shall be Victaulic grooved connections.
- F. Heat Exchanger Variable Flow Valves: Condenser and Evaporator heat exchangers shall be equipped with motorized modulating butterfly type valves driven independently by signals from the module controller and powered from the main power feed. The motorized actuators shall be NEMA 4X rated with easily visible position indicators and internal thermal motor overload protection. Valves shall be fast acting type with a maximum stroke time (full closed to full open) of 15 seconds. Load side valves shall modulate to maintain modular leaving load temperatures. When heat exchangers are using sink/source due to unequal heating/cooling duty, master controller shall modulate valve to provide minimum required head pressure control in order to maximize efficiency of those Chiller/Heater modules and to provide equipment protection. All valves must be installed such that proper piping practices are observed, including proper distances before and after elbows.
- G. General
 - 1. All Modules shall be ETL listed in accordance with UL Standard 1995, CSA certified per Standard C22.2#236.
 - 2. All modules shall be AHRI certified according to the AHRI 550 certification program.

- 3. Modules shall ship wired and charged with refrigerant. All modules shall be factory run tested prior to shipment on an AHRI certified test stand.
- 4. Compressors, heat exchangers, piping and controls shall be mounted on a heavy gauge steel frame. Electrical controls, contactors, and relays for each module shall be mounted within that module.
- H. Water Mains: Each module shall include supply and return mains for both load and source-sink water. Grooved end connections are provided for interconnection with Victaulic type couplings. Water Mains shall be installed such that they are beneath any power or control wiring so as to insure for safe operation in the event of condensation or minor piping leaks.
- I. Heat Exchangers: Each load and source-sink heat exchanger shall be brazed plate heat exchangers constructed of 316 stainless steel; designed, tested, and stamped in accordance with UL 1995 code for 650 psig working pressure on the load side and 650 psig working pressure on the source-sink. Both the load side and source-sink side heat exchangers shall be mounted below the compressor, to eliminate the effect of migration of refrigerant to the cold heat exchanger with consequent liquid slugging on start-up.
- J. All chiller/heater components including heat exchangers, compressors, expansion valve, and actuators shall be configured such that removal of these components can be accomplished without shutting down the entire assembly.
- K. Compressor: Each module shall contain two hermetic scroll compressors independently circuited and with internal spring isolation mounted to the module with rubber-in-shear isolators. Each system also includes high discharge pressure and low suction pressure manual reset safety cut-outs.
- L. Master Controller
 - 1. Sequencing and operation of the of the various compressors, VME Isolating Valves, and Heat Exchanger Variable Flow Valves shall be performed and coordinated by a microprocessor based controller to maximize efficiency and minimize system energy usage.
 - 2. The Master Controller shall monitor and report the following on each refrigeration system:
 - a. Discharge Pressure Fault
 - b. Suction Pressure Fault
 - c. Suction Temperature
 - d. Load Leaving Water Temperature
 - e. Source-Sink Leaving Water Temperature
 - 3. The Master Controller shall be powered by the chillers single point power connection and shall monitor and report the following system parameters:
 - a. Cooling Load Water Entering and Leaving Temperature
 - b. Heating Load Water Entering and Leaving Temperature
 - c. Source-Sink Water Entering and Leaving Temperature
 - d. Load Water (both heating and cooling) and Source-Sink Water Flow
 - 4. An out of tolerance indication from these controls or sensors shall cause a "fault" indication at the Master Controller and shutdown of that compressor with the transfer of load requirements to the next available compressor. In the case of a System Fault the entire Chiller/Heater will be shut down. When a fault occurs, the Master Controller shall record conditions at the time of the fault and store the data for recall. This information shall be capable of being recalled through the keypad of the Master Controller and displayed on the Master Controller's 2 line by 40 character back-lit LCD. A history of faults shall be maintained including date and time of day of each fault (up to the last 20 occurrences).
 - 5. Individual monitoring of leaving water temperatures from each refrigeration system shall be programmed to protect against heat exchanger freeze-up.

- 6. The control system shall evaluate the water temperatures of the heating and cooling systems to assess the required capacity of each and cycle compressors of the Chiller/Heater Modules, open/close VME Isolation Valves, and modulate Heat Exchanger Variable Flow Valves to meet load requirements, optimize efficiency, minimize system energy usage and equalize compressor run times.
- 7. Chiller/Heater shall have a single point power connection and external inputs and outputs to be compatible with the building management system. Hardwire Inputs/Outputs include:
 - a. Remote Start/Stop
 - b. General Alarm
 - c. Cooling Load Limit
 - d. Heating Load Limit
 - e. Cooling Load Reset
 - f. Heating Load Reset
- 8. The Chiller/Heater shall be capable of communicating the above points with the Building Automation System via an Interoperability Web Portal through ASHRAE Standard 135-2004 BACnet protocol to match that provided by the BAS contractor in Section 23 09 00. Additional points shall include:
 - a. Chiller/Heater leaving chilled water temperature
 - b. Chiller/Heater leaving hot water temperature
 - c. Chiller/Heater percent cooling capacity
 - d. Chiller/Heater percent heating capacity
 - e. Module level leaving condenser temperature
 - f. Module level leaving evaporator temperature
 - g. Individual Compressor Status On/Off
 - h. Condenser VME valves Open/Close status
 - i. Evaporator VME valve Open/Close status
 - j. Chilled water temperature setpoint
 - k. Heating water temperature setpoint
- M. BACnet Interface Devices: Provide BACnet Interface Devices for each Geothermal Water-to-Water Heat Pump so that the units are presented as a series of AV, BV and MSV BACnet objects. See 25 20 23.64.30 for the list of objects that must be supported. This list is the minimum acceptable.
- N. Single Point Power: Chiller shall be equipped with a pre-engineered genuine buss bar electrical system for single point power. Where the equipment size exceeds the amp rating of the buss bar, multiple power connections may be applied. Pre-engineered system shall also incorporate individual module isolation circuit breakers for full redundancy and ability of a module to be taken off-line for repair while the rest of the modules continue to operate. Individual power feeds to each module shall be unacceptable.
- O. Safeties, Controls and Operation
 - 1. Chiller/Heater safety controls system shall be provided with the unit (minimum) as follows:
 - a. Low refrigerant pressure
 - b. Loss of flow through the source/sink heat exchanger
 - c. Loss of flow through the load (cooling and/or heating) heat exchanger
 - d. High refrigerant pressure
 - e. High compressor motor temperature
 - f. Low suction gas temperature
 - g. Low leaving water temperature
 - 2. Failure of DHRC Chiller/Heater to start or Chiller/Heater shutdown due to any of the above safety cutouts shall be enunciated by display of the appropriate diagnostic description at the unit control panel. This annunciation will be in plain English. Alphanumeric codes shall be unacceptable.

- 3. The DHRC Chiller/Heater shall be furnished with a Master Controller as an integral portion of the Chiller/Heater control circuitry to provide the following functions:
 - a. Provide automatic Chiller/Heater shutdown during periods when the load level decreases below the normal operating requirements of the Chiller/Heater. Upon an increase in load, the Chiller/Heater shall automatically restart.
 - b. Provisions for connection to automatically enable the Chiller/Heater from a remote energy management system.
 - c. The control panel shall provide alphanumeric display showing all system parameters in plain English language with numeric data in English units.
 - d. If the Heat Pump module designated as the Master Controller fails for any reason, the Equipment Manufacturer's controller shall support the transfer of Master Controller responsibilities to the next Heat Pump module in an automatic fashion. Report this failure and transfer of responsibilities as a critical alarm to the building BAS via the BACnet/IP BACnet Interface Device provided in the Work.
- 4. Normal Chiller/Heater Operation
 - a. When DHRC Chiller/Heater is enabled, the factory supplied Master Controller modulates the Chiller/Heater heating and cooling capacity from minimum to maximum as required by building load.
 - b. The DHRC Chiller/Heater control system shall respond to Entering Water Temperature and will have an integral reset based on entering water temperature to provide for efficient operation at part-load conditions.
- 5. Power Phase Monitor
 - a. Provide a Power Phase Monitor on the incoming power supply to the Chiller/Heater. This device shall prevent the Chiller/Heater from operating during periods when the incoming power is unsuitable for proper operation.
 - b. The Power Phase Monitor shall provide protection against the following conditions:
 - 1) Low Voltage (Brown-Out)
 - 2) Phase Rotation
 - 3) Loss of Phase
 - 4) Phase Imbalance

2.02 SOURCE QUALITY CONTROL

- A. Perform functional test of heat pumps before shipping.
- B. Factory performance test heat pumps, before shipping, according to ARI 550/590, "Water Chilling Packages Using the Vapor Compression Cycle."
- C. Factory test and inspect evaporator and water-cooled condenser according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Stamp with ASME label.
- D. For heat pumps located indoors, rate sound power level according to ARI 575 procedure.

PART 3: EXECUTION

3.01 EXAMINATION

- A. Before heat pumps installation, examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, and electrical connections to verify actual locations, sizes, and other conditions affecting heat pumps performance, maintenance, and operations.
 - 1. Heat pumps locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 HEAT PUMPS INSTALLATION

- A. Install heat pumps on support structure indicated.
- B. Equipment Mounting: Install heat pumps on concrete bases using elastomeric pads. Comply with requirements in Division 03 Section
 - 1. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
- C. Maintain manufacturer's recommended clearances for service and maintenance.
- D. Charge heat pumps with refrigerant if not factory charged and fill with oil if not factory installed.
- E. Install separate devices furnished by manufacturer and not factory installed.

3.03 INSTALLATION OF BACnet INTERAFCE DEVICE

- A. See the Division 25 Responsibility Matrix for the execution responsibilities for Equipment Supplier, Controls and Electrical Subcontractor.
- B. The supplier is responsible for supplying and installing the BACnet Interface Device.
- C. Electrical is responsible for power and any control wiring if the device does not have a single point of connection.
- D. Division 25 is responsible for communicating with the BACnet Interface Device using BACnet objects and services to access this data and for mapping the BACnet objects from the device(s) in this Specification Section to the BACnet Object Integration Device to create graphics, reports, trends, alarms, schedules and other requirements specified in Division 25. Division 25 is only responsible for communicating with the BACnet Interface Device using BACnet objects and services to access this data.
- E. This BACnet Interface Device is a BACnet/IP device. See Division 27 for networking responsibilities.

3.04 CONNECTIONS

- A. Comply with requirements in Division 23 Section "Hydronic Piping" Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Comply with requirements in Division 23 Section "Refrigerant Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- C. Install piping adjacent to chiller to allow service and maintenance.
- D. Evaporator Fluid Connections: Connect to evaporator inlet with shutoff valve, strainer, flexible connector, thermometer, and plugged tee with pressure gage. Connect to evaporator outlet with shutoff valve, balancing valve, flexible connector, flow switch, thermometer, plugged tee with pressure gage, flow meter, and drain connection with valve. Make connections to heat pumps with a flange or mechanical coupling.
- E. Condenser Fluid Connections: Connect to condenser inlet with shutoff valve, strainer, flexible connector, thermometer, and plugged tee with pressure gage. Connect to condenser outlet with shutoff valve, balancing valve, flexible connector, flow switch, thermometer, plugged tee with pressure gage, flow meter, and drain connection with valve. Make connections to heat pumps with a flange, or mechanical coupling.

- F. Refrigerant Pressure Relief Valve Connections: For water chillers installed indoors, extend vent piping to the outside without valves or restrictions. Comply with ASHRAE 15.
- G. Connect each drain connection with a union and drain pipe and extend pipe, full size of connection, to floor drain. Provide a shutoff valve at each connection if required.
- H. Prior to connecting the Chiller/Heater to the condenser and chilled water loop, the piping loops shall be flushed with a detergent and hot water (110-130° F) mixture to remove previously accumulated dirt and other organics. In old piping systems with heavy encrustation of inorganic materials consult a water treatment specialist for proper passivation and/or removal of these contaminants.
- I. During the flushing, a 30 mesh (max.) Y-strainers (or acceptable equivalent) shall be in place in the system piping and examined periodically as necessary to remove collected residue. The flushing process shall take no less than 6 hours or until the strainers examined after each flushing are clean. Old systems with heavy encrustation shall be flushed for a minimum of 24 hours and may take as long as 48 hours before the filters run clean. Detergent and acid concentrations shall be used in strict accordance with the respective chemical manufacturers instructions. After flushing with the detergent and/or dilute acid concentrations the system loop shall be purged with clean water for at least one hour to ensure that all residual cleaning chemicals have been flushed out.

3.05 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.
- C. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
 - 1. Verify that refrigerant charge is sufficient and water chiller has been leak tested.
 - 2. Verify that pumps are installed and functional.
 - 3. Verify that thermometers and gages are installed.
 - 4. Operate water chiller for run-in period.
 - 5. Check bearing lubrication and oil levels.
 - 6. Verify that refrigerant pressure relief device for chillers installed indoors is vented outside.
 - 7. Verify proper motor rotation.
 - 8. Verify static deflection of vibration isolators, including deflection during water chiller startup and shutdown.
 - 9. Verify and record performance of chiller and condenser water flow and low-temperature interlocks.
 - 10. Verify and record performance of water chiller protection devices.
 - 11. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
- D. Prepare a written startup report that records results of tests and inspections.
- E. Coordinate start-up with the BAS contractor and commissioning agent.
- F. Engage a factory authorized service representative to perform and/or assist with integration of equipment with the Building Automation System as part of the commissioning process. This shall be a separate, second visit at a different date than startup.

3.06 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate and maintain geothermal water-to-water heat pumps. Refer to Division 01 Section "Demonstration and Training."
 - 1. Required Time: 8 hours.

B. Refer to 25 08 01, 25 08 02 and 25 20 23.64.30 for start-up, commissioning and training requirements for the BACnet Interface Devices provided in this Specification Section.

END OF SECTION 23 64 30

SECTION 23 73 13

CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes constant-volume and variable volume, factory fabricated, double wall, central-station airhandling units for indoor and outdoor installations.

B. Related Sections:

- 1. Section 25 09 23.73.13 Integrated Automation Stick Built UV Lamp Monitors for Central-Station Air-Handling Units (All Types).
- 2. Section 25 20 23.09.50 Integrated Automation BACnet Interface Device (Gateway/Native BACnet Devices) Variable Frequency Motor Controllers (All Types).
- 3. Section 25 20 23.73.13 Integrated Automation BACnet Interface Device (Gateway/Native BACnet Devices) Central-Station Air-Handling Units (All Types).
- 4. Section 25 20 23.84.13 Integrated Automation BACnet Interface Device (Gateway/Native BACnet Devices) Humidifiers for Central-Station Air-Handling Units (All Types).
- 5. Section 25 20 23.85 Integrated Automation BACnet Interface Device (Gateways/Native BACnet Devices) Air Flow Measuring Stations for Central-Station Air-Handling Units (All Types).
- 6. Section 25 00 13 Integrated Automation General Requirements All Trades Work Responsibilities.
- 7. Division 25 Schedule 3 BACnet Single Line Diagram and Responsibility Matrix (Applies to all Trades).

1.02 SUBMITTALS

- A. Product Data: For each air-handling unit indicated.
 - 1. Unit dimensions and weight.
 - 2. Cabinet material, metal thickness, finishes, insulation, and accessories.
 - 3. Fans:
 - a. AMCA 210 certified fan-performance curves with system operating conditions indicated.
 - b. AMCA 301 certified fan-sound power ratings at each octave band.
 - c. Fan construction details and accessories.
 - d. Motor ratings, electrical characteristics, and motor accessories.
 - 4. Coils:
 - a. AHRI 410 certified coil-performance ratings at the system operating conditions indicated.
 - b. Support frame details to include materials of construction.
 - c. Condensate drain pan and trap details to include materials of construction.
 - 5. Dampers, including housings, linkages, and operators.
 - 6. Air filters with performance characteristics and mounting frame details.
 - 7. Energy recovery devices with certified performance ratings at the operating conditions specified.
 - 8. Accessories as indicated.
- B. Wiring diagrams detailing wiring for power and controls and differentiating between manufacturer-installed wiring and field-installed wiring.
- C. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Mechanical-room layout and relationships between components and adjacent structural and mechanical elements.
 - 2. Support location, type, and weight.

- 3. Field measurements.
- D. Field quality control test reports specified in Part 3 of this Section.
- E. Maintenance data for central-station air-handling units for inclusion in Operating and Maintenance Manual specified in Division 1 and Division 23 Section 23 05 00 Common Work Results for HVAC.
- F. Include the BACnet Interface Device with Submittal showing proprietary points listed in 25 20 23.09.50 (VFDs), 25 20 23.73.13 (Central Station AHUs), 25 20 23.84.13 (Humidifiers for AHUs) and 25 20 23.85 (Air Flow Measuring Stations) are mapped to BACnet Object Types. Failure to do so will result in automatic rejection of the Submittal.

1.03 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled by a testing agency as defined in NFPA 70 and marked for intended location and application. Electrical components shall be acceptable to authorities having jurisdiction. Unit shall carry the ETL or UL sticker and certification.
- B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.
- C. AMCA Compliance: Comply with AMCA Standard 210-16 "Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating", and AMCA Standard 301-14, Methods For Calculating Fan Sound Ratings From Laboratory Test Data"
- D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2016, Section 5 "Systems and Equipment" and Section 7 "Construction and Startup."
- E. ASHRAE 90.1-2010 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2010, Section 6 "Heating, Ventilating, and Air Conditioning.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to the project site factory-assembled in the largest practical sizes (to the extent allowable by shipping limitations). Ship products with 12 mil poly shrink-wrap.
- B. Store in a clean, dry place. Protect from physical damage, water and moisture penetration, corrosion and general construction dirt and debris. Use extraordinary means to assure the units are turned over to the Owner in like-new condition without damage from shipping, storing or handling. Fans shall be rotated every two weeks by Contractor to minimize damage to the fan and motor bearings.
- C. Lift and support units with the manufacturer's designated lifting or supporting points.
- D. Disassemble and reassemble units as required for movement into the final location following manufacturer's written instructions.
- E. Deliver central-station air-handling units factory-assembled to the extent allowable by shipping limitations, with protective crating and covering.

1.05 COORDINATION

- A. Coordinate sizes and location of concrete bases with actual equipment provided.
- B. Coordinate size and location of structural-steel support members, if any, with actual equipment provided.

1.06 EXTRA MATERIALS

A. Provide a minimum of three sets of both pre and final filters for each unit. One set shall be installed during temporary operation. Monitor filter dust and debris build-up and replace as needed such that the total pressure drop across the filter bank does not exceed 1.0 in w.c. Install a clean set of both pre and final filters just prior to system balancing. Coordinate scheduling with the Test and Balance Contractor to ensure that new filters are installed when Test and Balance work begins. Deliver to the Owner all remaining filters. A minimum of one set of both pre and final filters shall be turned over. Obtain a receipt from the Owner that new filters have been installed and the quantity of additional filters that have been turned over.

PART 2: PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with requirements, manufacturers offering products which may be incorporated in the Work include the following:
 - 1. Custom Air Handling Units
 - a. Haakon
 - b. Temptrol
 - c. Scott Springfield

2.02 CUSTOM AIR HANDLING UNITS

- B. Custom air handling units shall be factory engineered and assembled to comply with all requirements here-in. Units shall consist of casings, internally isolated fans, motor and drive assembly, heating and cooling coils, condensate drain pans, energy recovery wheels, access and plenum sections, filters and mounting frames, mixing dampers, airflow stations, and accessories.
 - 1. Units shall be of the sizes, types, arrangements and capacities as indicated on the Drawings, Details, and Schedules.
 - 2. Unit dimensions shall be as indicated on the Drawings and Details with allowances made for minor variations in manufacturing methods.
 - a. Manufactured products with deviations less than plus or minus 3 inches in width or height, or 12 inches in overall length will be accepted.
 - b. Manufactured products with greater deviations that plus or minus 3 inches in width or height, or 12 inches in overall length will be considered only if it can be shown installation, service and maintenance clearances are not compromised.
 - c. 12 inches w.g. casing pressure or 1.5 times the peak static pressure rating of the supply fam whichever is greater.
 - d. Structural Performance: Unit casings shall be self-supporting and capable of withstanding 150 percent of internal static pressures indicated, plus 30-pounds per square foot of live load on the roof without panel joints exceeding a deflection of L/240 where "L" is the unsupported span length within a completed cabinet casing
 - e. See notes on the drawings for units that are required to be field assembled. Refer to part 3.0 for field assemble requirements.
- C. General Fabrication Requirements for Cabinets: Formed and reinforced 2 inch double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with sealed joints between each shipping section. Units over 30,000 cfm or over 8' tall shall have 4" walls.

- 1. Exterior Casing Walls: 16 gauge galvannealed steel. Clench individual panels to create a clean wall panel structure. Units utilizing post and panel construction shall have thermally broken posts to minimize heat transfer. TEK screws, bolt / nut assemblies, pop rivets, and adhesives shall not be used to secure panels to any structural member.
- 2. Interior Liner:
 - a. 22 gauge stainless steel cooling, mixing and humidifier section.
 - b. 22 gauge perforated galvanized steel-supply fan discharge and return fan inlet plenums for sound control. Provide hydrophobic mineral wool insulation to maximize sound attenuation.
 - c. 22 gauge thermally broken stainless steel panels in outside air sections.
 - d. 22 gauge solid galvanized steel in all other areas.
- 3. Floor: 1/8 inch aluminum tread-plate floor shall be welded to structural C-channels. Floor seams shall be continuously welded to form an integral water-tight drain pan 1.5" deep. No screws, bolts / nut assemblies, pop rivets, or adhesives shall be used to secure the floor to the structure. Floors shall not deflect more than 1/32 of an inch with a 300# live load.
- 4. Drain holes and or drain pans shall be located as shown on the drawings at the area downstream of the drain pan, outside air mixing section, and humidifier section
- 5. Base Pan Liner: 3" closed cell spray foams insulation with 18 gauge galvanized liner.
- 6. Unit cabinet shall be designed to withstand air pressure differentials up to 12 inches w.g. positive static pressure.
- 7. Air-Handling Unit Base Rail: 6 inch high structural steel C-channel designed for low deflection, and continuously welded with integral lifting lugs. Provide engineering calculations based on the design plenum pressure at the cooling coil section to assure that the condensate drain location will be of adequate height to drain the cooling coil condensate
- 8. Factory finish for galvannealed steel cabinets: Immediately after cleaning and pre-treating sheet metal apply Manufacturer's standard two (2) coat acrylic enamel finish consisting of prime coat and thermosetting top-coat. Custom color shall be selected by the Architect/Engineer.
- D. Casing Insulation and Adhesive:
 - 1. Materials: ASTM C 1071 Type II.
 - 2. Location and Application: Encased full thickness inches between solid inside and outside cabinet walls.
 - 3. Acoustical Insulation at Perforated Casing Walls: Encased full thickness inches mineral wool insulation between inside and outside cabinet walls with the air-stream surface with a Tedlar temperature and moisture resistant neoprene coating.
- E. Access Door Fabrication: Formed and reinforced double wall and insulated panels of the same materials and thicknesses as unit casing Access Doors:
 - 1. Door Hinges: Stainless steel piano hinge and two (2) Ventlok #310 wedge-lever-type metal latches, operable from inside or outside. Doors shall be designed to open against air pressure differential. Plastic handles are not acceptable.
 - 2. Gasket: EPDM automotive type bulb seal applied around entire perimeter of access doors.
 - 3. Windows: Fabricate 10" round windows in access section doors of double-glazed, safety glass with an air space between the panes and sealed with interior and exterior rubber seals. Windows in UV sections shall be designed to block 99.9% of the UV light rays.

- 4. Door Size: Minimum 24 inches wide x full height of unit casing up to a maximum height of 60 inches, or as indicated on the Drawings. Doors must be the same thickness as the unit casing to maximize thermal and acoustical resistance
- 5. Provide a fan and filter section access door wide enough to remove the motor, fan wheel, or filters but not less than 24" wide.
- 6. Test Ports: Provide one (1) inch diameter test ports for unit air stream testing in each access section. Test ports shall have a tube that extends between the inside and outside of the unit and a screwed cap on the exterior to allow access
- F. Fan, Motor, and Drive Sections:
 - Provide direct or belt drive fans as indicated on the equipment schedules. The fan assembly shall be factory
 installed inside unit casings on vibration isolation springs and structural C-channel steel bases. Fans shall be
 selected for stable operation at both 100% of design airflow at design static pressure, and at 50% of design
 airflow at 25% of the design static pressure. In no case shall a fan be selected at more than 85% of peak
 design static pressure. In direct-drive applications the motors shall be shall be selected as close to the
 synchronous speed of the motor as possible. All fan wheels shall be optimized to produce the highest possible
 fan static efficiency.
 - 2. Provide flexible duct connection on the inlet of each plenum fan.
 - 3. Provide thrust restraints, OSHA approved belt guards, inlet screens, and OSHA approved fan cages. Belt guards shall be sized to allow fan and belt sheaves to be increased by two sizes.
 - 4. Tapered roller or spherical bearings shall have an L10 life of 200,000 hours
 - 5. Fans shall be AMCA 210/300 rated for Air and Sound Performance.
 - 6. Motor removal I-beams: Beams shall be installed in the fan section to remove the fan motors. Trolley shall be supplied by the Owner.
 - 7. Motors: Refer to Division 23 Section "Common Motor Requirements for HVAC Equipment" and 25 20 23.09.50 VFDs for requirements.
 - 8. Acoustical Diffuser: Provide acoustical diffuser to attenuate the noise in the mid-octave bands and provide efficiency enhancement. Two diffuser sections mounted at the front and back of the fan impeller. Acoustic attenuating material is inserted within a solid housing and a perforated front plate that directs airflow across the diffuser reducing fan noise and increasing static efficiency.
- G. Coil Section:
 - 1. Fabricate coil sections to allow for unimpeded access for service and maintenance of coil(s).
 - 2. Coil header and return bends shall be completely enclosed by the air-handling unit casing. Piping connections, including air vents and coil drains, shall extend to outside the casing through rubber grommet holes and escutcheons sealed with industrial silicone caulk.
 - 3. Provide sheet metal blank-offs around coil(s) to prevent air from bypassing around them.
 - 4. Water coils shall have 5/8" x 0.025 inch tube walls, and 0.010 inch thick aluminum fins. Provide coils with 1/2" x .020 inch tubes if the flow is less than 25 GPM to increase the fluid tube velocity. Manufacture shall circuit the coils to maintain a fluid tube velocity rate between 3-5 fps. Turbospirals are not allowed to artificially increase the fluid velocity rate. Cooling coils shall not be higher than 48" header height. Coil Ubends shall be full tube thickness.
 - 5. Provide stainless steel coil casings for cooling coils and galvanized steel coil casings for heating coils to mitigate corrosion.

- 6. Individual Coil Racking: All cooling coil racking shall be constructed of #304 stainless steel, and heating coil racking shall be galvanized steel. All coils shall be individually racked so that if any one coil needs to be replaced the adjacent coil and piping will not be disturbed, and be available for service. Provide access panels to remove the individual coils from the side of the unit.
- 7. Coil Removal: Coils and coil sections shall be mounted on coil racks designed to allow the coils to be removed individually by sliding out through removable access panels in the casing wall. Racks for the cooling coils shall be stainless steel, and heating coil racks shall be galvanized. Racks that slide the coils out through access doors are not acceptable.

H. Pans:

- 1. Material: Continuously welded, 304 stainless steel sheet.
- 2. Fabricated with slope in two planes to collect condensate from cooling coils including coil piping connections, coil headers, and return bends to direct water toward drain connections.
- 3. Length: Extend main drain pan downstream from leaving face of coil to comply with the latest version of ASHRAE 62.1, but not less than 18".
- 4. Depth: 1.5 inches deep
- 5. Units with stacked coils shall have an intermediate stainless steel sloped drain pan and stainless steel downspout drain extension to collect condensate from the upper coils. Slope pan towards the cooling coil to minimize condensate formation on the underside of the pan. Main drain pans shall be designed so the drain pan is at least 18" from the leaving edge of the cooling coil.
- 6. Stainless Steel Drain Connection: Located at lowest point of drain pan and sized to prevent overflow. Terminate with threaded nipple on access door side of drain pan.
- 7. Manufacturer shall provide a certified drain pan trap detail for fabrication by the Contractor based on plenum design pressures in the cooling coil sections.
- I. Steam Distribution Tube:
 - 1. Provide DriSteem steam dispersion manifold with insulated #304 SS tubes rated at scheduled capacity and steam pressure. Casings shall be constructed of 304 stainless steel. Factory mount the steam distribution manifolds and the distribution piping in the coil section and extend tubes thru the casing using escutcheons and high temperature silicone. Mechanical Contractor shall be responsible for the connection from the steam humidifier piping to the piping. Provide Models as shown below:
 - a. DriSteem Ultrasorb Model MP for use with pressurized or atmospheric steam, and same side supply steam inlet/outlet connections.
 - 2. Provide double sloped stainless steel drain pan beneath humidifier section. Drain connection shall be on one side.
 - 3. Refer to Specification Section 23 84 13 "Humidifiers" for Humidifier requirements.
 - 4. Refer to Specification Section 25 20 23.84.13 for Humidifier BACnet Interface Device Requirements.
- J. Sensible and Latent Heat Wheel:
 - 1. General: Dehumidification wheels shall be desiccant coated rotary air-to-air heat exchangers meeting the performance as listed in equipment schedules.
 - 2. Flame and Smoke Test and Rating: Wheels shall have a flamespread rating of 25 or less and smoke-developed rating of 50 or less as tested in accordance with ASTM E84.
 - 3. Wheel shall constructed of alternate layers of corrugated and flat aluminum.

- 4. Wheels shall be coated with a corrosion-prohibiting, non-migrating, permanently-bonded desiccant adsorbent specifically developed for the selective transfer of water vapor.
- 5. The air channels shall be formed smooth to ensure laminar airflow for low-pressure drops and allow free passage of particles up to 900 microns in diameter.
- 6. Rotor structure shall be internally reinforced and mounted on flange type bearings.
- 7. The rotor shall also be removable from the frame.
- 8. Brush seals shall be provided around the periphery of the rotor and between the inlet and outlet air passages to effectively prevent air leakage and cross contamination between airflows.
- 9. An adjustable purging sector shall be installed to prevent carryover of air from one side of the wheel to the other.
- 10. Cross contamination shall be verified in writing by an independent laboratory confirming that the desiccant surface freely transmits water vapor without detectable gaseous cross contamination.
- 11. Sensible and latent recovery performance and leakage must be clearly measured and certified through ARI in accordance with the AMCA 1060 Standard.
- 12. Factory mounted electronic speed control shall provide soft-start/stop, rotation detection and alarm, and selfcleaning jog functions.
- 13. The rotor drive system shall consist of an adjustable belt around the rotor perimeter driven by an AC motor with gear reduction. The variable speed drive shall be specifically designated for heat wheel applications and include: an AC inverter, soft start/stop, rotation detection w/alarm contacts, automatic self cleaning function, and self testing capability.
- 14. The speed controller shall be capable of accepting a potentiometer, VDC, or mA control signal.
- 15. Controls: The control of wheel rotational speed is to be by the use of a variable frequency drive (VFD) rated for the full rpm range of the wheel. The wheel speed shall be modulated in response to a signal from air stream temperature sensors mounted in the air ducts. The temperature sensors shall be supplied by the BMS/BAS controls vendor. The speed controller shall be energized by a remote signal from the owner's BMS/BAS.
- 16. BACnet Interface Devices: Provide BACnet Interface Devices for each Variable Frequency Motor Controller so that the units are presented as a series Provide of AV and BV BACnet objects. See 25 20 23.09.50 for the list of objects that must be supported. This list is the minimum acceptable.
- K. Dampers: General Leakage rate when tested in accordance with AMCA Standard 500 Test Method for Louvers, Dampers and Shutters, shall not exceed 1 percent of air quantity calculated at 2,000 fpm face velocity through damper and 4.0 inches wag. pressure differential.
 - 1. Provide all dampers shown within the air handling units.
 - 2. Damper operators are specified in Division 23 Section 23 09 00 "Building Automation System."
 - 3. Dampers for outside, and exhaust air shall be low leakage, insulated Tamco Series 9000, no substitute.
 - 4. Dampers for return air, or bypass shall be Tamco Series 1000, no substitute.
 - 5. Provide face and by-pass dampers at the heating coil for all variable air volume units and where noted on the drawings.

- L. Filter Section: Filters shall comply with NFPA Standard 90A "Standard for the Installation of Air Conditioning and Ventilating System".
 - 1. Outside and Return Air: Provide filter section and media as indicated where required to protect heat recovery components.
 - a. Provide disposable type air filters 2 inches thick, consisting of viscous coated fibers with filtering media encased in fiberboard cell sides having perforated metal grids on each face to provide media support. Airflow resistance with clean media shall not exceed 0.10 inch wag. at face velocity of 300 fpm. Filters shall have a MERV 8 efficiency rating in accordance with ASHRAE Test Standard 52 - Method of Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
 - 2. Supply Air Extended Surface Filters: Provide filter section and media as indicated.
 - a. Pre-Filters: Provide disposable type air filters 2 inches thick, consisting of viscous coated fibers with filtering media encased in fiberboard cell sides having perforated metal grids on each face to provide media support. Airflow resistance with clean media shall not exceed 0.20 inch wag. at face velocity of 300 fpm. Filters shall have a MERV 8 efficiency rating in accordance with ASHRAE Test Standard 52 Method of Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
 - b. Extended Surface Self-Supporting Filters: Provide factory-fabricated, dry, extended surface, self-supporting filters with holding frames; where indicated, in sizes indicated. Equip with UL Class I fibrous media material constructed so that individual pleats are maintained in tapered form by flexible internal supports under rated air flow conditions. Construct holding frames of 18 gauge galvanized steel and provide suitable fasteners and gasketing to hold filter units and prevent unfiltered air particles between media frames and holding devices. Design holding frames which are suitable for bolting together into built-up filter banks. Provide filters with rate face velocity of 500 fpm, initial resistance of 0.25" wag. Filters shall have a MERV 13 efficiency rating in accordance with ASHRAE Test Standard 52 Method of Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
- M. Air Flow Stations: Provide factory-mounted fan inlet airflow traverse probes on the inlet of all fans to continuously measuring air volume.
 - 1. Shall contain multiple total and static pressure sensors connected to an averaging manifold.
 - 2. Sensors shall be designed to eliminate adverse effects of airflow particle contamination.
 - 3. Traverse probes shall be of aluminum construction, with anodized finish.
 - 4. Probes shall not induce a measurable pressure drop or amplify sound levels.
 - 5. Accuracy: 3% of actual air flow, as per U.S.G.A. certification tests.
 - 6. Provide electronic transducers for a 4-20mA or 0-10 volt signal to the building system.
 - 7. See 25 20 23.85 for Air Flow Station BACnet Interface Device Requirements.
- J. Ultra Violet Lights:
 - 1. Provide factory mounted UV Resources Model DEF-SO UV stainless steel fixtures and lights as shown on the Drawings. Include all necessary stainless steel mounting brackets to provide one row of lights for every 24" of vertical coil surface. Lights shall be mounted at a distance of 12" from the cooling coils, and cover the entire length of the unit. Include two (2) sets of bulbs to be turned over to the Owner at start-up. Do not ship bulbs with the Equipment to minimize damage.
 - 2. Provide a UV-C Lamp Hour Meter c/w Analog Output for monitoring lamp runtime hours. See 25 09 23.73.13 for BACnet Stick Built Device requirements.

- N. Electrical: Provide factory-mounted and wired electrical components, devices, and accessories in accordance with the requirements of Division 26 Sections. Factory wiring shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency, and marked for intended location and application. Provide at a minimum the following:
 - 1. Marine lights shall be provided in all access sections wired to a single switch. GFCI outlets provided in fan access segments. Lights and GFCI's shall be provided on a separate 120/1 volt circuit with a single point connection.
 - 2. Provide empty conduit, raceway, and junction boxes for field installation of control wiring. A junction box shall be provided in unit section. The conduit penetration of the unit casing shall be sealed air tight.
 - 3. Electrical power wiring connections for the unit fans shall be provided to each of the variable frequency drives with connection in conduit to the motors. Variable frequency drives are provided by the Building Automation System Contractor and field installed by the Electrical Contractor. Coordinate locations for VFD's and identify locations on the air handling unit submittals.
 - 4. The unit wiring diagram shall be provided in the panel.
- O. BACnet Interface Devices: Provide BACnet Interface Devices for each Central-Station Air-Handling Unit so that the units are presented as a series of AV, BV and MSV BACnet objects. See 25 20 23.73.13 for the list of objects that must be supported. This list is the minimum acceptable.

PART 3: EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances, housekeeping pads, and other conditions affecting performance of central-station air-handling units.
- B. Examine casing insulation materials and filler media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.
- C. Examine rough-in for hydronic, condensate drainage piping and electrical to verify actual locations of connections prior to installation.
- D. Do not proceed until unsatisfactory conditions have been corrected.

3.02 INSTALLATION, GENERAL

- A. Install central-station air-handling units level and plumb, in accordance with manufacturer's written instructions.
 - 1. Support floor-mounted units on concrete equipment bases. Secure units to anchor bolts installed in concrete equipment base.
- B. Arrange installation of units to provide access space around air-handling units for service and maintenance.
- C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used or during construction with new clean filters.

3.03 INSTALLATION OF BACnet INTERAFCE DEVICES

- A. See The Division 25 Responsibility Matrix for the execution responsibilities for Equipment Supplier, Controls and Electrical Subcontractor.
- B. The supplier is responsible for supplying and installing the BACnet Interface Device.
- C. Electrical is responsible for power and any control wiring if the device does not have a single point of connection.

- D. Division 25 is responsible for communicating with the BACnet Interface Device using BACnet objects and services to access this data and for mapping the BACnet objects from the device(s) in this Specification Section to the BACnet Object Integration Device to create graphics, reports, trends, alarms, schedules and other requirements specified in Division 25. Division 25 is only responsible for communicating with the BACnet Interface Device using BACnet objects and services to access this data.
- E. This BACnet Interface Device is a BACnet/IP device with BACnet MS/TP device components the VFDs and the Air Flow Stations. See Division 27 for BACnet/IP networking responsibilities. Division 25 is responsible for networking the BACnet MS/TP devices to a BAS Contractor provided BACnet/IP device.

3.04 EQUIPMENT BASES

- A. Construct concrete equipment pads as follows:
 - 1. Coordinate size of equipment bases with actual unit sizes provided. Construct base 4 inches larger in both directions than the overall dimensions of the supported unit.
 - 2. Place anchor bolts and sleeves to facilitate securing units.
 - 3. Allow concrete to cure before installation of units.
 - 4. Clean exposed steel form and apply 2 coats of rust-preventative metal primer.

3.05 CONNECTIONS

- A. Piping installation requirements are specified in Section 23 21 13 "Hydronic Piping". The Drawings indicate the general arrangement of piping, valves, fittings, and specialties. The following are specific connection requirements:
 - 1. Arrange piping installations adjacent to units to allow unit servicing and maintenance.
 - 2. Connection piping to air-handling units with flexible connectors.
 - 3. Connect condensate drain pans using 1-1/4-inch, Type M copper tubing. Extend to the nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.
- B. Duct installations and connections are specified in Section 23 31 13 "Ductwork" and 23 33 00 "Air Duct Accessories". Make final duct connections with flexible connections.
- C. Connection requirements for units shipped in sections.
 - 1. The mechanical contractor is responsible for all field wiring required as a result of units shipped in sections. Complete wiring in accordance with manufacturer's instructions and guidelines. Comply with all NEC requirements. Field wiring shall be verified and approved by the equipment manufacturer and shall not void the warranty.
- D. Electrical Connections: The following requirements apply:
 - 1. Electrical power wiring is specified in Division 26.
 - 2. Temperature control wiring and interlock wiring is specified in Section 23 09 00 Building Automation System
 - 3. Grounding: Connect unit components to ground in accordance with the National Electrical Code.

3.06 FIELD QUALITY CONTROL

- A. Manufacturer's Field Inspection: Arrange and pay for a factory-authorized service representative to perform the following:
 - 1. Inspect the field assembly of components and installation of central-station air-handling units including piping, ductwork, and electrical connections.
 - 2. Prepare a written report on findings and recommended corrective actions.

3.07 ADJUSTING, CLEANING, AND PROTECTING

- A. Adjust water coil flow, with control valves to full coil flow, to indicated gpm.
- B. Adjust damper linkages for proper damper operation.
- C. Clean unit cabinet interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheel, fan cabinet, and coils entering air face.

3.08 SYSTEM START-UP

- A. Provide the services of a factory authorized service representative to provide start-up services.
- B. Final Checks Before Start-Up: Perform the following operations and checks before start-up:
 - 1. Remove shipping, blocking, and bracing.
 - 2. Verify unit is secure on mountings and supporting devices and that connections for piping, ductwork, and electrical are complete. Verify proper thermal overload protection is installed in motors, starters, and disconnects.
 - 3. Perform cleaning and adjusting specified in this Section.
 - 4. Disconnect fan drive from motor and verify proper motor rotation direction and verify fan wheel free rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.
 - 5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
 - 6. Set outside-air and return-air mixing dampers to minimum outside-air setting.
 - 7. Comb coil fins for parallel orientation.
 - 8. Install clean filters.
 - 9. Verify manual and automatic volume control, and fire and smoke dampers in connected ductwork systems are in the full-open position.
 - 10. Disable automatic temperature control operators.
- C. Starting procedures for central-station air-handling units:
 - 1. Energize motor, verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated RPM.
 - a. Replace fan and motor pulleys as required to achieve design conditions.
 - 2. Measure and record motor electrical values for voltage and amperage.

- D. Shut unit down and reconnect automatic temperature control operators.
- E. Refer to Division 1 Section 23 90 00 "Testing, Adjusting, and Balancing" for procedures for air-handling-system testing, adjusting, and balancing.
- F. See Division 25 08 00, 25 08 01 and 25 08 02 and the Related Sections listed above in this Specification Section for BAS and BACnet Interface Device commissioning requirements. Complete point forms for all points supplied and installed by Equipment Supplier. Division 25 shall complete forms for all points supplied and installed by Division 25.
- G. Engage a factory authorized service representative to perform and/or assist with integration of equipment with the Building Automation System as part of the commissioning process. This shall be a separate, second visit at a different date than startup.

3.09 TEMPORARY OPERATION

- A. Manually operate air handling systems to provide suitable environment for installation of interior finishes. Perform commissioning operations prior to starting units. Follow commissioning starting procedures and the following manual operation sequence:
 - 1. Open outdoor air dampers, close return air dampers, open all air terminals to full open. Verify filters installed, heating coil operating (outdoor air temperatures below 40° F), condensate drain functioning, and electrical protection devices installed. Start fan, monitor indoor and outdoor conditions, and manually operate heating and cooling systems to control space conditions; shut down systems completely and close outdoor air dampers at end of each work day.

3.10 PROJECT CLOSEOUT

- A. Replace fan drives and sheaves as directed by the Engineer as required for systems to perform to the intended design conditions. The Contractor's bid shall include labor and materials required to replace the quantity of drives and sheaves specified in Part 1.0 "Extra Materials."
- B. Replace fan motors as directed by the Engineer as required for systems to perform to the intended design conditions. The Contractor's bid shall include all material and labor required to replace the quantity at motors, specified in Part 1.0 "Extra Materials."

3.11 DEMONSTRATION AND TRAINING

- A. Train Owner's maintenance personnel to adjust, operate and maintain central-station air handling units. Refer to Division 01 Section "Demonstration and Training."
 - 1. Required Time: 8 hours.
- A. Refer to 25 08 00, 25 08 01 and 25 20 23.73.13 for start-up, commissioning and training requirements for the BACnet Interface Devices provided in this Specification Section.

END OF SECTION 23 73 13

SECTION 23 81 23

COMPUTER-ROOM AIR-CONDITIONERS

PART 1: GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Floor-mounted computer-room air conditioners, 6 tons and larger.
 - 2. Ceiling-mounted computer-room air conditioners.

B. Related Sections:

- 1. Section 25 20 23.81.23 Integrated Automation BACnet Interface Device (Gateway/Native BACnet Devices) Computer-room Air-conditioners (All Types).
- 2. Section 25 00 13 Integrated Automation General Requirements All Trades Work Responsibilities.
- 3. Division 25 Schedule 3 BACnet Single Line Diagram and Responsibility Matrix (Applies to all Trades).
- 4. Section 25 25 23.81.23 Integrated Automation Wired Connection CRAG Unit Condensate Pumps (All Types). Section 25 25 23.81.23 – Integrated Automation – Wired Connection – CRAC Unit Condensate Pumps (All Types).

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For computer-room air conditioners. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.
- C. Color Samples: For unit cabinet, discharge grille, and exterior louver and for each color and texture specified.
- D. Coordination Drawings: Plans, elevations, and other details, drawn to scale, using input from Installers of the items involved.
- E. Field quality-control reports.
- F. Operation and Maintenance Data: For computer-room air conditioners to include in emergency, operation, and maintenance manuals.
- G. Warranty: Sample of special warranty.
- H. Include the BACnet Interface Device with Submittal showing proprietary points listed in 25 20 23.81.23 are mapped to BACnet Object Types. Failure to do so will result in automatic rejection of the Submittal.

1.03 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance:
 - 1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
- C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1
- D. ASME Compliance: Fabricate and label water-cooled condenser shell to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.

1.04 COORDINATION

- A. Coordinate layout and installation of computer-room air conditioners and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.
- B. Coordinate installation of computer-room air conditioners with computer-room access flooring Installer.
- C. Coordinate sizes and locations of concrete bases with actual equipment provided.
- D. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.05 WARRANTY

- A. Special Warranty:
 - 1. General: 3-year warranty, including all parts (motors, fans, shafts, bearings, valves, control parts and control boards). Excludes consumables (filters, humidifier bulbs, and canisters).
 - 2. Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.

1.06 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filters: One set(s) of filters for each unit.

PART 2: PRODUCTS

2.01 FLOOR-MOUNTED UNITS 6 TONS AND LARGER

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following.
 - 1. Vertiv (Liebert Corporation).
- B. Description: Packaged, factory assembled, prewired, and prepiped; consisting of cabinet, fans, filters, humidifier, and controls.

- C. Cabinet and Frame: Welded steel, braced for rigidity, and supporting compressors and other mechanical equipment and fittings.
 - 1. Doors and Access Panels: Galvanized steel with polyurethane gaskets, hinges, and concealed fastening devices.
 - 2. Insulation: Thermally and acoustically insulate cabinet interior with 1-inch- thick duct liner.
 - 3. Finish of Exterior Surfaces: Baked-on, textured vinyl enamel; color as selected from manufacturer's standard colors.
 - 4. Floor Stand: Welded tubular steel, with adjustable legs and vibration isolation pads. Refer to the drawings for required height to match raised floor.
- D. Supply-Air Fan(s):
 - 1. The fans are plug/plenum type, single inlet and shall be dynamically balanced. The drive package shall be direct drive, electronically commutated (EC) and variable speed. The fans shall be located to draw air over the A-frame coil to ensure even air distribution and maximum coil performance. EC fans shall operate within the unit cabinet, instead of underfloor.
- E. Refrigeration System:
 - 1. Compressors: Semi-hermetic scroll; with internal motor overload protection, resilient suspension system, crankcase heater, manual-reset high-pressure switch, and pump-down low-pressure switch.
 - 2. Refrigeration Circuits: Two; each with hot-gas mufflers, thermal-expansion valve with external equalizer, liquid-line solenoid valve, liquid-line filter-dryer, sight glass with moisture indicator, service shutoff valves, charging valves, and charge of refrigerant.
 - 3. Refrigerant Evaporator Coil: Alternate-row or split-face-circuit, direct-expansion coil of seamless copper tubes expanded into aluminum fins.
 - a. Mount coil assembly over stainless-steel drain pan having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir.
 - 4. Remote Air-Cooled Refrigerant Condenser: Corrosion-resistant cabinet, copper-tube aluminum-fin coils arranged for two circuits, multiple direct-drive variable speed EC fans with permanently lubricated ball bearings, and single-phase motors with internal overload protection and integral electric control panel and disconnect switch. Control capacity by modulating fan speeds.
 - 5. The system shall be capable of minus 30 degrees F operation with LeeTemp utilizing head master and heated receiver.
- F. Hydronic Cooling Coil: Seamless copper tubes expanded into aluminum fins with modulating three-way control valve. Refer to drawing for water or cooling medium.
 - 1. Control Valve: Class 125 body.
 - a. Maximum Pressure Drop: 5 psig at design flow rate.
 - b. Close-Off (Differential) Pressure Rating: 100 percent of pressure differential across valve or 100 percent of total system (pump) head.
 - 2. Mount coil assembly over stainless-steel drain pan complying with ASHRAE 62.1 and having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir.

- G. Dual Cooling Source Systems: The dual cooling source system shall consist of an air or water cooled compressorized system with the addition of a chilled water coil, a modulating control valve, and a comparative temperature sensor. The system shall be able to function either as a modulating chilled water system or as a compressorized system, or a combination of both. The primary mode of cooling shall be chilled water. Switchover between the two cooling modes shall be performed automatically by the microprocessor control.
- H. Electric-Resistance Heating Coil: Enclosed finned-tube electric elements arranged for minimum of three stages, with thermal safety switches, manual-reset overload protection, and branch-circuit overcurrent protection.
- I. Extended-Surface, Disposable, Panel Filter: Pleated, lofted, nonwoven, reinforced cotton fabric; supported and bonded to welded-wire grid; enclosed in cardboard frame with 2-inch- thick, disposable, glass-fiber prefilter.2.01.
 - 1. Thickness: 4 inches.
 - 2. Initial Resistance: .3
 - 3. Recommended Final Resistance: 1.0
 - 4. Arrestance (ASHRAE 52.1): 45 percent.
 - 5. Merv (ASHRAE 52.2): 8
- J. Infrared Humidifier: High-intensity quartz lamps mounted above stainless-steel evaporator pan, serviceable without disconnecting water, drain, or electrical connections; prepiped and using condensate water from cooling coils with stainless-steel or brass float-valve mechanism; located in bypass airstream; with flush-cycle timer and solenoid drain valve.
- K. Integral Electrical Controls: Unit-mounted electrical enclosure with piano-hinged door, grounding lug, combination magnetic starters with overload relays, circuit breakers and cover interlock, and fusible control-circuit transformer.
- L. Disconnect Switch: Remote disconnect provided by Division 26 contractor.
- M. Microprocessor-Control System: Continuously monitors operation of process cooling system; continuously displays room temperature and room relative humidity; sounds alarm on system malfunction and simultaneously displays problem. If more than one malfunction occurs, system displays fault in sequence with room temperature and continues to display fault when malfunction is cleared until system is reset.
 - 1. Malfunctions:
 - a. Power loss.
 - b. Loss of airflow.
 - c. Clogged air filter.
 - d. High room temperature.
 - e. Low room temperature.
 - f. High humidity.
 - g. Low humidity.
 - h. Smoke/fire.
 - i. Water under floor.
 - j. Supply fan overload.
 - k. Compressor No. 1 Overload.
 - 1. Compressor No. 1 Low Pressure.
 - m. Compressor No. 1 High Pressure.
 - n. Compressor No. 2 Overload.
 - o. Compressor No. 2 Low Pressure.
 - p. Compressor No. 2 High Pressure.
 - 2. Digital Display:
 - a. Control power on.
 - b. Humidifying.
 - c. Dehumidifying.

- d. Compressor No. 1 Operating.
- e. Compressor No. 2 Operating.
- f. Heat operating.
- g. Chilled water cooling.
- h. DX cooling.
- 3. Push buttons shall stop and start process cooling system, silence audible alarm, test indicators, and display room's relative humidity.
- 4. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display unit status and alarms.
 - a. Provide a BACnet/IP BACnet Interface Device for each CRAC unit to allow the building BAS to to remotely control and monitor the unit from an operator workstation. Control features and monitoring points displayed locally at unit control panel shall be available through the BAS.
- 5. Provide each unit with an iCOM microprocessor control 7" color touchscreen for user input and monitoring.
- 6. The iCOM control panels shall be wired together by the Teamwork Mode wiring. If the master fails, control responsibility passes automatically to the next computer room unit.
- N. Factory Options:
 - 1. Provide Vertiv Liqui-tect water cabling to detect leaks on the floor. Include all wiring, controller(s), and components as necessary to wire back to CRAC units to shut down upon detection of water.
 - 2. Condensate Pump, Dual Float: The condensate pump shall have a minimum capacity of 145 gph at 20ft hd. It shall be complete with integral dual-float switches, pump-and-motor assembly and reservoir. The secondary float shall send a signal to the local alarm and shut down the unit upon high water condition.
 - 3. Damper end switch interlock terminals.
- O. BACnet Interface Devices:
 - 1. Provide BACnet Interface Devices for each Computer-room Air-conditioner so that the units are presented as a series of AV, BV and MSV BACnet objects. See 25 20 23.81.23 for the list of objects that must be supported. This list is the minimum acceptable.
 - 2. Each CRAC unit shall have their own peer BACnet/IP BACnet Interface Device and shall communicate with other on a peer-to-peer basis. BACnet Interface Devices that act as a Master controller to control the CRAC units as subordinate or slave devices are not allowed in the Work.

2.02 FAN MOTORS

- A. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment", including, but not limited to, efficiency and power factor correction requirements.
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

PART 3: EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for hydronic piping systems to verify actual locations of piping connections before equipment installation.
- C. Examine walls, floors, and roofs for suitable conditions where computer-room air conditioners will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install computer-room air conditioners level and plumb, maintaining manufacturer's recommended clearances.
- B. Install roof-mounting units on equipment supports where indicated. Roof supports are specified in Division 07 and in architectural details of construction. Provide lag bolt with gasketed washer to fasten mechanical unit to curb. Also refer to manufacturer's installation instructions.
- C. Computer-Room Air-Conditioner Mounting: Install using elastomeric pads.
- D. Air-Cooled Refrigerant Condenser Mounting: Install using elastomeric pads.
- E. Install water sensor and all associated components and wire back to unit controls to shut down unit upon detection of water.

3.03 INSTALLATION OF BACnet INTERFACE DEVICE

- A. See the Division 25 Responsibility Matrix for the execution responsibilities for Equipment Supplier, Controls and Electrical Subcontractor.
- B. The supplier is responsible for supplying and installing the BACnet Interface Device.
- C. Electrical is responsible for power and any control wiring if the device does not have a single point of connection.
- D. Division 25 is responsible for communicating with the BACnet Interface Device using BACnet objects and services to access this data and for mapping the BACnet objects from the device(s) in this Specification Section to the BACnet Object Integration Device to create graphics, reports, trends, alarms, schedules and other requirements specified in Division 25. Division 25 is only responsible for communicating with the BACnet Interface Device using BACnet objects and services to access this data.
- E. This BACnet Interface Device is a BACnet/IP device. See Division 27 for networking responsibilities.

3.04 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Water and Drainage Connections: Comply with applicable requirements in Division 22 Section "Domestic Water Piping." Provide adequate connections for water-cooled units, condensate drain, and humidifier flushing system.

- D. Chilled-Water Heating Piping: Comply with applicable requirements in Division 23 Section "Hydronic Piping." Provide shutoff valves in inlet and outlet piping to cooling coils.
- E. Refrigerant Piping: Comply with applicable requirements in Division 23 Section "Refrigerant Piping." Provide shutoff valves and piping.

3.05 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 - 1. Inspect for and remove shipping bolts, blocks, and tie-down straps.
 - 2. After installing computer-room air conditioners and after electrical circuitry has been energized, test for compliance with requirements.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Computer-room air conditioners will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.
- F. After startup service and performance test, change filters and flush humidifier.
- G. Engage a factory authorized service representative to perform and/or assist with integration of equipment with the Building Automation System as part of the commissioning process. This shall be a separate, second visit at a different date than startup.

3.06 ADJUSTING

- A. Adjust initial temperature and humidity set points.
- B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.07 DEMONSTRATION AND TRAINING

- A. Train Owner's maintenance personnel to adjust, operate and maintain computer-room air-conditioners. Refer to Division 01 Section "Demonstration and Training."
 - 1. Required Time: 6 hours.
- B. Refer to 25 08 01, 25 08 02 and 25 20 23.81.23 for start-up, commissioning and training requirements for the BACnet Interface Devices provided in this Specification Section.

END OF SECTION 23 81 23

SECTION 23 82 19

FAN COIL UNITS

PART 1 : GENERAL

1.01 SUMMARY

- A. This Section includes fan-coil units and accessories.
- B. Related Sections:
 - 1. Section 25 20 23.82.19 Integrated Automation BACnet Interface Device (Gateway/Native BACnet Devices) Fan Coil Units (All Types).
 - 2. Section 25 00 13 Integrated Automation General Requirements All Trades Work Responsibilities.
 - 3. Division 25 Schedule 3 BACnet Single Line Diagram and Responsibility Matrix (Applies to all Trades).

1.02 SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Ceiling suspension components.
 - 2. Structural members to which fan-coil units will be attached.
 - 3. Method of attaching hangers to building structure.
 - 4. Size and location of initial access modules for acoustical tile.
- D. Field quality-control test reports specified in Part 3.0 of this section.
- E. Maintenance data for fan coil units for inclusion in the Operating and Maintenance manual specified in Division 1 and Division 23 Section 23 05 00 Common Work Results for HVAC.
- F. Include the BACnet Interface Device with Submittal showing proprietary points listed in 25 20 23.82.19 are mapped to BACnet Object Types. Failure to do so will result in automatic rejection of the Submittal.

1.03 QUALITY ASSURANCE

A. 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.

1.04 COORDINATION

A. Coordinate layout and installation of fan-coil units and suspension system components with other construction that penetrates or is supported by ceilings, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

1.05 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fan-Coil-Unit Filters: Furnish one spare filters for each filter installed.
 - 2. Fan Belts: Furnish one spare fan belts for each unit installed.

PART 2 : PRODUCTS

2.01 FAN-COIL UNITS

- A. Subject to compliance with requirements, provide products by one of the manufacturers specified.
 - 1. Enviro-Tech
 - 2. Daikin
 - 3. Airtherm; a Mestek Company.
 - 4. Carrier Corporation.
 - 5. McQuay International.
 - 6. Trane.
 - 7. YORK International Corporation.
- B. Description: Factory-packaged and -tested units rated according to ARI 440, ASHRAE 33, and UL 1995.
- C. Coil Section Insulation: 1-inch foil-faced glass fiber complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.
 - 1. Fire-Hazard Classification: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
- D. Drain Pans: Stainless steel formed to slope form all directions to the drain connection as required by ASHRAE 62.
- E. Chassis: Galvanized steel where exposed to moisture, with baked-enamel finish and removable access panels.
- F. Cabinets: Steel with baked-enamel finish in manufacturer's standard paint color.
 - 1. Supply-Air Plenum: Sheet metal plenum finished and insulated to match the chassis as necessary for ducted connection.
 - 2. Return-Air Plenum: Sheet metal plenum finished to match the chassis as necessary for ducted connection.
- G. Filters: Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
 - 1. Glass Fiber Treated with Adhesive: 80 percent arrestance and 5 MERV.
- H. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain.
- I. Direct-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, multispeed motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.

2.02 BACnet INTERFACE DEVICES

- A. Provide BACnet Interface Devices for each Fan Coil Unit so that the units are presented as a series of AV, BV and MSV BACnet objects. See 25 20 23.82.19 for the list of objects that must be supported. This list is the minimum acceptable.
- B. The controls for the devices in this Specification Section are BACnet MS/TP controllers that once approved via the Submittal process, shall be sent to the Equipment Supplier's factory for factory mounting. Failure to do so will require Division 25 to field install all the controls.
- C. Division 25 is responsible for the BACnet MS/TP network communications wiring to all equipment provided in this Specification Section.

PART 3 : EXECUTION

3.01 EXAMINATION

- A. Examine areas to receive fan-coil units for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in for piping and electrical connections to verify actual locations before fan-coil-unit installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install fan-coil units level and plumb.
- B. Install fan-coil units to comply with NFPA 90A.
- C. Suspend fan-coil units from structure with elastomeric vibration hangers.
- D. Install new filters in each fan-coil unit within two weeks after Substantial Completion.

3.03 INSTALLATION OF BACnet INTERFACE DEVICES

- A. See the Division 25 Responsibility Matrix for the execution responsibilities for Equipment Supplier, Controls and Electrical Subcontractor.
- B. The supplier is responsible for supplying and installing the BACnet Interface Device.
- C. Electrical is responsible for power and any control wiring if the device does not have a single point of connection.
- D. Division 25 is responsible for communicating with the BACnet Interface Device using BACnet objects and services to access this data and for mapping the BACnet objects from the device(s) in this Specification Section to the BACnet Object Integration Device to create graphics, reports, trends, alarms, schedules and other requirements specified in Division 25. Division 25 is only responsible for communicating with the BACnet Interface Device using BACnet objects and services to access this data.
- E. This BACnet Interface Device is a BACnet MS/TP device. See Division 25 for networking responsibilities.

3.04 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
 - 1. Install piping adjacent to machine to allow service and maintenance.
 - 2. Connect piping to fan-coil-unit factory hydronic piping package. Install piping package if shipped loose.
 - 3. Connect condensate drain to indirect waste.
 - a. Install condensate trap of adequate depth to seal against the pressure of fan. Install cleanouts in piping at changes of direction.
- B. Connect supply and return ducts to fan-coil units with flexible duct connectors specified in Division 23 Section "Air Duct Accessories." Comply with safety requirements in UL 1995 for duct connections.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.05 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust fieldassembled components and equipment installation, including connections. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
 - 3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Engage a factory authorized service representative to perform and/or assist with integration of equipment with the Building Automation System as part of the commissioning process. This shall be a separate, second visit at a different date than startup.

3.06 ADJUSTING

- A. Adjust initial temperature and humidity set points.
- B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

3.07 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate and maintain fan coil units. Refer to Division 01 Section "Demonstration and Training."
 - 1. Required Time: 2 hours.
- B. Refer to 25 08 01, 25 08 02 and 25 20 23.82.19 for start-up, commissioning and training requirement for the BACnet Interface Devices provided in this Specification Section.

END OF SECTION 23 82 19

SECTION 23 84 13

HUMIDIFIERS WITH WATER TREATMENT SYSTEM

PART 1: GENERAL

1.01 SUMMARY

This Section includes the following:

- 1. Self-contained resistive humidifiers.
- 2. Water treatment system including softeners, dechlorinator and reverse osmosis.
- 3. Intent is to provide a fully assembled, pre-piped water treatment and humidifier system(s).

B. Related Sections:

- 1. Section 25 20 23.84.13 Integrated Automation BACnet Interface Device (Gateway/Native BACnet Devices) Humidifier (All Types).
- 2. Section 25 00 13 Integrated Automation General Requirements All Trades Work Responsibilities.
- 3. Division 25 Schedule 3 BACnet Single Line Diagram and Responsibility Matrix (Applies to all Trades).

1.02 DEFINITION

A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.03 SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Detail fabrication and installation of humidifiers. Include piping details, plans, elevations, sections, details of components, manifolds, and attachments to other work.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Coordination Drawings: Detail humidifiers and adjacent equipment. Show support locations, type of support, weight on each support, required clearances, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Structural members to which humidifiers will be attached.
 - 2. Size and location of initial access modules for acoustical tile.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For humidifiers to include in operation and maintenance manuals.
- F. Include the BACnet Interface Device with Submittal showing proprietary points listed in 25 20 23.84.13 are mapped to BACnet Object Types. Failure to do so will result in automatic rejection of the Submittal.

1.04 QUALITY ASSURANCE

A. 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.

B. Comply with ARI 640, "Commercial and Industrial Humidifiers.

1.05 COORDINATION

A. Coordinate location and installation of humidifiers with manifolds in ducts and air-handling units or occupied space. Revise locations and elevations to suit field conditions and to ensure proper humidifier operation.

1.06 WARRANTY

A. Product shall be warranted to be free from defects in materials and fabrication for a period of two years after installation or 27 months from ship date.

PART 2: PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers listed shall provide a complete system of equipment listed here-in, and there shall not be mixing and matching of manufacturers amongst different equipment(s). Subject to compliance with requirements, provide products by one of the following:
 - 1. Dri-Steem Corporation.
 - 2. Armstrong International, Inc.
 - 3. Carel USA, LLC.
 - 4. Carnes Co., Inc.
 - 5. Herrmidifier.
 - 6. Hygromatik; Spirax Sarco, Inc.
 - 7. Nortec Industries Inc.

2.02 SELF-CONTAINED HUMIDIFIERS

- A. The basis of design is Dri-Steem Corporation RTS electric steam humidifier.
- B. General: Provide electric resistive evaporative steam humidifiers of size, capacity, and configuration as indicated on the drawings.
 - 1. Tank and heater plate:
 - a. Tank and heater plate: 14-gauge 304-stainless steel with Heli-arc welded seams.
 - b. Tank bottom shall be dual sloped with side exit drain port located at bottom of slopes to ensure complete draining of tank.
 - c. Steam outlet on top of tank configured to connect to hose and pipe (NPT or BSP connection) for all sizes, and including flanged pipe connection option on -3 and -4 stage units.
 - d. Quick removable heater plate with weld studs, flange nuts and gasketed flanges shall be located at the front of the tank. There shall be no in board flange on tank to allow for easy tank cleaning.
- C. Immersion heater(s): Heater(s) shall be Incoloy alloy-sheathed resistance type designed for no more than 91 watts per square inch. Two threaded ends of each heater element shall pass through the heater plate at the front of the evaporating chamber and be secured and sealed with Thermoseal synthetic gaskets, safety washers, and threaded nuts.
- D. Mounting: Humidifier shall be mounted on a wall using lag bolts (-1 and -2 stage models) or the humidifier shall be mounted directly to the floor (-3 and -4 stage models).

- E. Water type, fill, and drain requirements:
 - 1. The humidifier shall be capable of generating steam from well, tap, softened, DI or RO water.
 - 2. The humidifier shall not require changes to controls or components in the field due to changes in water type.
 - 3. The humidifier shall sense water purity and automatically adjust drain rates accordingly to minimize tank maintenance and optimize water usage.
 - 4. Fill line plumbing shall include anti-siphoning mechanisms that prevent tank siphoning and potential inlet water contamination.
 - 5. Humidifier shall incorporate a water surface skimming feature to drain away water surface debris and contaminants to minimize tank cleaning maintenance and risk of foaming.
 - 6. An electric full port ball valve shall be mounted on humidifier assembly to allow tank to drain automatically at the end of a humidification season.
 - a. Provide complete tank draining with no standing water.
 - b. Minimum 5 gpm flow rate for fast draining.
 - c. The system shall monitor drain water temperature with temperature viewable on the unit's display.
 - 7. Integral water tempering control shall meter cold water at the drain in order to temper 212°F water to a maximum 140°F discharge temperature at full drain rate to sanitary system during normal operation.
 - a. Drain water tempering shall employ closed loop feedback using the drain temperature sensor to automatically control the drain and fill valves. Drain water temperature shall not exceed 140 °F while system shall minimize (cold) water usage by not excessively tempering.
 - b. Minimize drain and refill time by sensing when water is no longer draining (tank empty) to quickly initialize refilling of tank and subsequent re-start of humidification.
- F. Manifold: ASTM A 666, Type 316 stainless-steel tube(s) extending across entire width of duct or plenum and equipped with mounting brackets on ends.
- G. Control Panel:
 - 1. Factory-wired disconnect switch.
 - 2. Liquid-crystal display.
 - 3. Programmable keyboard.
 - 4. Set-point adjustment.
 - 5. Warning signal indicating end of replaceable cylinder life.
 - 6. Low-voltage, control circuit.
 - 7. Diagnostic, maintenance, alarm, and status features.
 - 8. High-water sensor to prevent overfilling.
- H. Controls:
 - 1. Microprocessor-based control system for modulating or cycling control, and start/stop and status monitoring for interface to central HVAC instrumentation and controls.
 - 2. Solenoid-fill and automatic drain valves to maintain water level and temper hot drain water.
 - 3. Field-adjustable timer to control drain cycle for flush duration and interval.

- 4. Controls shall drain tanks if no demand for humidification for more than 72 hours.
- 5. Conductivity-type level controls.
- 6. Interoperability using BACnet IP only.
- I. BACnet Interface Devices:
 - 1. Provide BACnet Interface Devices for each Humidifier so that the units are presented as a series of AV, BV and MSV BACnet objects. See 25 20 23.84.13 for the list of objects that must be supported. This list is the minimum acceptable.
- J. Accessories:
 - 1. Airflow switch for preventing humidifier operation without airflow.

2.03 WATER SOFTENER

- A. Basis of design is Dri-Steem Hydrotrue water softener.
- B. Duplex water pre-treatment components and piping shall include:
 - 1. Electronic metered control valve(s) with integrated bypass valve (1" models).
 - 2. Two resin tanks.
 - 3. Support gravel.
 - 4. Strong-acid cationic resin, polystyrene cross linked with 8% divinylbenzene structure. NSF-44 certified. Sodium ionic form.
 - 5. Two sets of internal distribution.
 - 6. Brine line flow control.
 - 7. Drain line flow control based on the size of the resin tank.
 - 8. Water meter for efficient backwash capabilities.
 - 9. High density polyethylene (HDPE) brine tank with lid and brine valve.
 - 10. Solid-state microprocessor with front panel display.
 - 11. Micro-switch kit.

2.04 DECHLORINATOR

- A. Basis of design is Dri-Steem Hydrotrue dechlorinator.
- B. Water pre-treatment dechlorinator components and piping shall include:
 - 1. Granular, activated-carbon filter, 12 x 40 mesh, coconut based, compliant with ANSI B604.
 - 2. Electronic control valve(s) with integrated bypass valve (1" models).
 - 3. One resin tank.

- 4. Support gravel.
- 5. One set of internal distribution.
- 6. Darian line flow control based on the size of the resin tank.
- 7. Solid-state microprocessor with front panel display.
- 8. Micro-switch kit.

2.05 REVERSE OSMOSIS (RO) SYSTEM

- A. Basis of design is Dri-Steem Hydrotrue RO-200 series.
- B. RO water treatment system shall include:
 - 1. Frame: Frame shall be steel, primed and finished with powder-coat epoxy paint. Frame shall be equipped for and support loads imposed during rigging and operation. Frame shall house RO pump and system control components described below.
 - 2. Sizing: RO system shall be rated for flow at 50°F inlet water temperature.
 - 3. Membrane Angled Vessel(s): RO system shall have angled membrane vessel(s) for easy membrane removal.
 - 4. Components:
 - a. Brass rotary pump and premium efficient ODP motor with drip cover.
 - b. RO membrane(s): Extra low energy thin-film composite (TFC), high-efficiency, high-flow filtering membrane(s).
 - c. RO Pressure Vessel(s): Stainless steel with clamp style (U-pin not excepted).
 - d. Automatic inlet feed solenoid valve, brass construction.
 - e. Permeate flow meter, panel mounted.
 - f. Concentrate flow meter, panel mounted.
 - g. Recycle flow meter, panel mounted.
 - h. Concentrate to drain control valve.
 - i. Recycle control valve.
 - j. Permeate control valve.
 - k. Low pressure pump protection.
 - 1. Pressure transmitter for filter inlet, filter outlet, tank pressure; 316L SS material.
 - m. Liquid filled pressure gauges for filter in/out and system pressures, panel mounted, SS construction.
 - n. TDS sensor with LED display.
 - o. System on-off with pressure kit and dual shut-off valves.
 - p. Permeate manifold for connections to pressurized tank and process equipment.
 - q. Microprocessor controller with LED keypad display.
 - r. Water inlet low-pressure detection.
 - s. Automatic membrane fast flush on startup capability.
 - t. Automatic membrane flush based on inactivity capability.
 - u. 5-micron sediment filter.
 - v. 10-micron carbon cartridge (quantity 2).
 - w. Pressurized RO holding tank mounted on RO frame.
 - 5. Permeate Storage Tank:
 - a. Manufacturer shall provide a 4.4 gallon painted carbon steel storage tank with rubber bladder. The tank shall have one water connection and an air Schrader valve to fill the bladder side with compressed air.

6. Controls:

- a. Microprocessor-based control system to monitor, control, and/or adjust the following parameters:
 - 1) System alarms and system messages, current and previous.
 - 2) Adjustable water flush duration and frequency. Programmable outputs for remote signaling of alarms and/or messages.
 - 3) System diagnostics that include:
 - a) Test outputs function to verify component operation.
 - b) Test RO function, by simulating demand to validate performance.
 - c) Data collection of TDS, inlet pressure, post filter pressure, storage tank pressure, water pump hours, alarms, and service messages for viewing from the keypad/display or Web interface.
 - 4) Password-protected system parameters.
 - 5) Keypad/display or Web interface displays in English languages.
 - 6) Numerical units displayed in inch-pound or SI units.
 - 7) Interoperability using BACnet IP only.

2.06 SKID MOUNT

- A. Water treatment system components and humidifiers shall be skid mounted and pre-piped at the factory.
- B. Frame: Frame shall be steel, primed and finished with powder-coat epoxy paint. Frame shall be equipped for and support loads imposed during rigging and operation. Frame shall house all softeners, dechlorinators, RO system components, humidifiers, support piping, and electrical boxes.
- C. System Components: System shall be placed on the frame and secured with straps.
- D. Piping: The water treatment system on the skid shall be plumbed at the manufacturer allowing for one connection, made in the field, for water inlet, humidifier outlet, and all drains.
- E. Electrical: Frame shall have a mounted electrical box for one point of connection to the power supply of each piece of equipment. The internal wiring shall be done by the manufacturer.
- F. Support Legs: Frame shall come with thread able feet to allow for field leveling.

PART 3: EXECUTION

3.01 EXAMINATION

- A. Examine ducts, air-handling units, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before humidifier installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install humidifiers with required clearance for service and maintenance.
- B. Seal humidifier manifold duct or plenum penetrations with flange.
- C. Install humidifier manifolds in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

- D. Install water treatment system in accordance with manufacturer's most current installation guidelines and maintain all recommended clearances for service and maintenance.
- E. Install steam generator level on concrete base. Concrete base is specified in Division 23 Section "Common Work Results for HVAC."
- F. Concrete Bases: Anchor steam generator to concrete base.
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
 - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 5. Cast-in-place concrete materials and placement requirements are specified in Division 03.

3.03 INSTALLATION OF BACnet INTERFACE DEVICES

- A. See the Division 25 Responsibility Matrix for the execution responsibilities for Equipment Supplier, Controls and Electrical Subcontractor.
- B. The supplier is responsible for supplying and installing the BACnet Interface Device.
- C. Electrical is responsible for power and any control wiring if the device does not have a single point of connection.
- D. Division 25 is responsible for communicating with the BACnet Interface Device using BACnet objects and services to access this data and for mapping the BACnet objects from the device(s) in this Specification Section to the BACnet Object Integration Device to create graphics, reports, trends, alarms, schedules and other requirements specified in Division 25. Division 25 is only responsible for communicating with the BACnet Interface Device using BACnet objects and services this data.
- E. This BACnet Interface Device is a BACnet/IP device. See Division 27 for networking responsibilities.

3.04 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
 - 1. Install piping adjacent to humidifiers to allow service and maintenance.
 - 2. Install shutoff valve, strainer, backflow preventer, and union in humidifier makeup line.
- B. Install electrical devices and piping specialties furnished by manufacturer but not factory mounted.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.05 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, adjust and commission components, assemblies, and equipment installations, including connections. Coordinate with commissioning of the building and report results in writing.
- B. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Engage a factory authorized service representative to perform and/or assist with integration of equipment with the Building Automation System as part of the commissioning process. This shall be a separate, second visit at a different date than startup.

3.06 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate and maintain humidifiers with water treatment system. Refer to Division 01 Section "Demonstration and Training."
 - 1. Required Time: 6 hours.
- B. Refer to 25 08 00, 25 08 01 and 25 20 23.84.13 for start-up, commissioning and training requirements for the BACnet Interface Devices provided in this Specification Section.

END OF SECTION 23 84 13

Division 25 Addendum

Note: **Bold Double Underline text** is an insertion. Strikeout text is a deletion.

Refer to 25 00 11

1. Change 1.04.1.7.1 to read as follows:

Section 25 20 EV Charging Stations BACnet Interface Device shall be provided by the Division 25 BAS Contractor using BACnet Web Services. See this Section for details. <u>BACnet</u> Interface Device deleted.

2. Change 1.07.1.1 to read as follows:

Integration of the EV charging stations as outlined in 25 20 26.26.53. **<u>BACnet Interface</u>**

3. Change 1.15.1.1 to read as follows:

Division 25 BAS Contractor shall allow for a minimum maximum of 40,000 BACnet Object Types to be mapped.

4. Change 1.15.1.2 to read as follows:

Division 25 BAS Contractor shall allow for a minimum maximum of 5,000 BACnet Object Types that shall be writeable. This includes any MSOs and MSVs Als, AOs, AVs, Bls, BOs, BVs, MSIs, MSOs and MSVs that need to be writeable.

5. Change 1.15.1.4 to read as follows:

Division 25 BAS Contractor may use one or more BAS hardware panel(s) and/or a software device to host the mapped points. If a software device is used, the Division 25 BAS Contractor will be charged by the Owner for the cost (estimated at \$4,000) to spin up and maintain a VM for this purpose. PCs or other embedded computers not supplied by Lake County IT are not allowed in the Work. Provide a BACnet Object Integration Device software application to be installed on a VM spun up by Owner. See BACnet Single Line Diagram and Responsibility Matrix Addendum for details.

Refer to 25 00 13

1. Change 1.13.4.11 to read as follows:

<u>Graphics Column</u>: This is to be done by Division 25 BAS Contractor. under a separate contract with the Owner.

2. Change 1.13.4.12 to read as follows:

<u>Trend Column</u>: This is to be done by Division 25 BAS Contractor. -under a separate contract with the Owner.

Refer to 25 06 00

1. Change Schedule 3 attachment reference to read as follows:

SCHEDULE 3 – BACNET SINGLE LINE DIAGRAM AND RESPONSIBILITY MATRIX (APPLIES TO ALL TRADES)

The Schedule is attached as a separate item in the Contract Documents. <u>The BACnet Single</u> <u>Line Diagram and Responsibility Matrix has been entirely re-issued as Addendum</u> <u>01</u>.

The revised Schedule 3 BACnet Single Line Diagram and Responsibility Matrix is attached to this Addendum.

Refer to 25 08 02

Revise all the following clauses as specified below:

1.11 Recommissioning Manual

1.11.1 Not required.

1.12 One Year Commissioning Review

- 1.12.1 <u>Not required.</u> The Commissioning Authority shall conduct a One (1) Year Commissioning Review prior to the end of the warranty period. Review the current building operation with the facility maintenance staff. The review shall include outstanding issues from original or seasonal testing.
 - 1.12.1.1 The Division 25 BAS Contractor shall carry the costs of fifty (50) journeyman/senior personnel hours to participate in the One (1) Year Commissioning Review, during the warranty period. Allow for a minimum of two (2) trips to the Work to address these issues. These trips shall be made as close as possible to a winter and a summer design day condition. Travel time to the Work and traveling costs are in addition to this hourly allowance and are the Division 25 BAS Contractor's responsibility to bear. This Work includes the following:
 - 1.12.1.1.1 Review of all mechanical equipment for which commissioning sheets have been prepared
 - 1.12.1.1.2 Recommission twenty percent (20%) of all Controls hardware points and twenty percent (20%) of all terminal equipment (VAV boxes, reheats, terminal heating equipment)
 - 1.12.1.1.3 Review of all water and electrical utility data collected during the one (1) year period.
 - 1.12.1.1.4 Participate in a two (2) day review of trend data collected during the warranty period.
 - 1.12.1.1.5 Division 25 BAS Contractor shall update the O&M manuals and Record Documents as necessary due to this Work.

1.13 Occupant Concerns Review

1.13.1 Not required.

1.14 Final Commissioning Report <u>BAS Components</u>

- 1.14.1 The Commissioning Authority shall compile a final Commissioning Report. Summarize all of the tasks, findings, conclusions, and recommendations of the commissioning process. Indicate the actual performance of the building systems in reference to the Design Intent and contract documents. Include completed pre-functional inspection checklists, functional performance testing records, diagnostic monitoring results, identified deficiencies, recommendations, and a summary of commissioning activities.
 - 1.14.1.1 The Commissioning Authority shall distribute this report electronically. Recipients are responsible for printing their own copies.

1.15 Deferred/Seasonal Testing of BAS Components

- 1.15.1 This Work includes testing of equipment (e.g., heating equipment) that shall be done under winter conditions. This Work includes testing of the BAS components of the heating equipment to be tested under winter conditions. This Work also includes the testing of the BAS components of the cooling equipment to be tested under summer conditions.
- 1.15.2 The Commissioning Authority will attempt to schedule such testing so as to avoid this requirement. Division 25 BAS Contractor shall allow for 24 hours for seasonal commissioning if commissioning Work cannot be arranged in a shoulder season (spring or fall).
- 1.15.3 The need for such deferred/seasonal testing will not be used to delay granting Substantial Completion.
- 1.15.4 There is no <u>See Division 26 for</u> deferred/seasonal testing for Electrical.

1.15.5 See Division 23 for deferred/seasonal testing for Mechanical.

2 - PRODUCTS

2.01 **Test Equipment**

2.01.1 The Division 25 BAS Contractor shall provide all test equipment needed for the Work of this Specification section.

3 - EXECUTION

3.01 Commissioning Binder BAS Components

- 3.01.1 Division 25 BAS Contractor shall prepare <u>the BAS Components of the</u> Commissioning Binder based on the direction from the Commissioning Authority. The Table of Contents is as follows:
 - 3.01.1.1 Submittal Review By Commissioning Authority
 - 3.01.1.2 Basis of Design and Design Intent Documents By Design Team
 - 3.01.1.3 Commissioning Plan and Commissioning Schedule
 - 3.01.1.4 Start-Up/Pre-Functional Checklists/Equipment Startup Reports/Functional Performance Test Forms
 - 3.01.1.5 Deficiency Report and Resolution Record
 - 3.01.1.6 Deferred/Seasonal Testing
 - 3.01.1.7 Final Commissioning Report
- 3.01.2 Commissioning Authority shall provide one (1) printed copy of the Commissioning Binder to the Owner.

Refer to 25 15 11

1. Change 2.01.3 to read as follows:

The Level 0 Front End software configuration shall support the full expansion of the BAS network without the addition of BAS field devices. In order to facilitate future expansion and addition of the BAS systems, either within the local building or remote buildings, the Front End software licence provide as part of the Work shall support at least 100,000 hardware and software objects located on Lake County's BACnet Internetwork. <u>See 25 00 11 1.12.4 and sub-clauses for license requirements.</u>

2. Change 2.09.2 to read as follows:

The Level 0 Web server and the Level 0 Front End licenses provided in the Work shall allow for <u>the object and concurrent user requirements specified in 25 00 11 1.12.4 and sub-</u><u>clauses.</u>

Refer to 25 15 11.01

1. Change 3.02 to read as follows:

Site, Floor and Roof Plan Base Plan Graphics <u>Refer to Contract Documents for updated</u> <u>Site, Floor and Roof Base Plans to use in graphics creation.</u>

2. Change 3.02.7.1 to read as follows:

Provide a floor plan showing the Camera and Card Reader equipment. The Owner will provide a colorization and symbol standard. The Division 25 BAS Contractor shall create a Camera and Card Reader Floor Plan graphic similar to the Fire Alarm Floor Plan graphic. **BACnet Interface Device deleted**.

3. Change 3.03 to read as follows:

Mechanical and Electrical Room Graphics <u>Refer to Contract Documents for updated</u> <u>Mechanical and Electrical Room Base Plans to use in graphics creation.</u>

4. Change 3.31.3 to read as follows:

Refer to E5.01 for an updated One-Line Diagram.

5. Change 3.33.1 to read as follows:

Create equipment graphic(s) for each piece of equipment provided in the Work. Use graphic images that represent the make and model used in the Work. Obtain the equipment graphic from the Equipment Supplier or from the Equipment Supplier's web site. Create a table of points and show the Present_Values for each point. If the point count exceeds 10 points, only put the points deemed to be critical by the Owner on the main graphic. Put the remaining points in a table in a sub-graphic. Follow the colorization standard specified in 25-15-11. Provide a clickable link from the relevant floor plan location to this equipment graphic. All graphics shall be approved by Owner. BACnet Interface Device deleted.

6. Change 3.41.1 to read as follows:

Create equipment graphic(s) for each piece of equipment provided in the Work. Use graphic images that represent the make and model used in the Work. Obtain the equipment graphic from the Equipment Supplier's web site. Create a table of points and show the Present_Values for each point. If the point count exceeds 10 points, only put the points deemed to be critical by the Owner on the main graphic. Put the remaining points in a table in a sub graphic. Follow the colorization standard specified in 25-15-11. Provide a clickable link from the relevant floor plan location to this equipment graphic. All graphics shall be approved by Owner. BACnet Interface Device deleted.

7. Change 3.43.1 to read as follows:

Create equipment graphic(s) for each piece of equipment provided in the Work. Use graphic images that represent the make and model used in the Work. Obtain the equipment graphic from the Equipment Supplier or from the Equipment Supplier's web site. Create a table of points and show the Present_Values for each point. If the point count exceeds 10 points, only put the points deemed to be critical by the Owner on the main graphic. Put the remaining points in a table in a sub-graphic. Follow the colorization standard specified in 25-15-11. Provide a clickable link from the relevant floor plan location to this equipment graphic. All graphics shall be approved by Owner. BACnet Interface Device deleted.

8. Change 3.43.2 to read as follows:

Create a table of access control devices based on the Contract Drawings. Spot the cameras on the floor plan graphic for security devices. **BACnet Interface Device deleted.**

9. Change 3.44.1 to read as follows:

Create equipment graphic(s) for each piece of equipment provided in the Work. Use graphic images that represent the make and model used in the Work. Obtain the equipment graphic from the Equipment Supplier or from the Equipment Supplier's web site. Create a table of points and show the Present_Values for each point. If the point count exceeds 10 points, only put the points deemed to be critical by the Owner on the main graphic. Put the remaining points in a table in a sub graphic. Follow the colorization standard specified in 25-15-11. Provide a clickable link from the relevant floor plan location to this equipment graphic. All graphics shall be approved by Owner. BACnet Interface Device deleted.

10. Change 3.44.2 to read as follows:

Create a table of cameras based on the Contract Drawings. Spot the cameras on the floor plan graphic for security devices. **BACnet Interface Device deleted**.

Refer to 25 15 11.02

1. Change 3.01.11 to read as follows:

Refer to E5.02 for an updated Utility and End Use Metering Matrix.

Refer to 25 20 22.11.23.13

1. Change occurrences of reference to this Division 25 Specification Section number to 25 20 22.11.24.

Refer to 25 20 23.36.00

1. Change 1.01.1.1 to read as follows:

Division 25 BAS Contractor is responsible for providing all equipment and all BACnet Interface Devices for the flow meters <u>Air Terminal Units</u> and is designated as the Equipment Supplier in this Specification section.

Refer to 25 20 23.84.13

1. Change 1.01.1 to read as follows:

This Specification section outlines the Work requirements for the Division 25 BAS Contractor, Division 23 and Computer Room Air Conditioner <u>Humidifiers with Water Treatment</u> Equipment Supplier (referred to in this Specification section as the Equipment Supplier) responsible for the BACnet Interface Device for this equipment outlined in this section.

Refer to 25 20 26.26.53

1. Delete this Division 25 Specification Section entirely.

Refer to 25 20 26.36.50

1. Delete this Division 25 Specification Section entirely.

Refer to 25 20 28.13.00

1. Delete this Division 25 Specification Section entirely.

Refer to 25 20 28.23.00

1. Delete this Division 25 Specification Section entirely.

Schedule 3 BACnet Single Line Diagram and Responsibility Matrix is attached to this Addendum.

End of Addendum

This Schedule applies to all Trades included in the Work of this Bid.

This Schedule contains 37 pages including this page.

The BACnet Single Line Diagram and the Responsibility Matrix

have been re-issued by Division 25 Addendum 01.

There are no changes to the Responsibility Matrix.

Section 25 06 00 Page i Division 25 Addendum 01 2023-02-14

This box requires Division 26 to provide orange conduit and pull wire for Cat 6 cable to within 3 ft. of the BACnet Interface Device.

Division 27 shall then install the purple Cat 6 IP cable from BACnet/ IP device to patch panel designated by Owner.

BACnet/IP Built-Up or Plant Controller BACnet Interface Device

Devices in this color box are BACnet/IP Controller(s)

Devices in this color box are BACnet MS/TP Controller(s)

Devices in this color box are Proprietary protocol controls by Equipment Supplier

Devices in this color box require stick built controls by Division 25 BAS Contractor.

Devices in this color box require Aux Contact controls on Equipment Supplier equipment to be wired by Division 25 BAS Contractor.

Devices in this color box require BACnet/IP communications between two devices to create a single Built-up BACnet Interface Device..

Blue boxes show device architecture and special wiring requirements.

Note: This grayed out box provides a special note that apply to specific BACnet Interface Devices.

BACnet Web Services (WS) integration by Division 25.

The Responsibility Matrix provides additional details on Work Responsibilities for each BACnet Interface Device Type

Devices and any safeties or interlocks in red shall be UL listed devices

This signifies Work that Simplex shall be responsible for providing in this project.



This box and the arrow above represents BACnet/IP communications on the Owner's Enterprise LAN.

> The solid line and this note when applied to a specific BACnet Interface Device indicates that the specific BACnet Interface Device has been deleted from Scope of Work.

When the "nn" reference is used it refers to all Division 25 specification sections with 25 07, 25 09, 25 20 and 25 25 that are in the Division 25 Specification and this BACnet Single Line Diagram and Responsibility Matrix.

Attend Co-ordination Meeting per Division 25 07 nn, 25 20 nn, 25 09 nn, 25 20 nn and 25 25 nn Sections (nn refers to the sections included in the Division 25 Specification)

The BACnet Single Line Diagram and the Responsibility Matrix have been re-issued by Division 25 Addendum 01. There are no changes to the Responsibility Matrix

Map the points found in the BACnet Interface Devices listed in the Division 25 Specification and summarized below.

The BACnet Interface Devices for the Electric Vehicle Charging Stations, the Portable Generator Docking Stations, the Access Control System and the Video Surveillance System have been deleted by Addendum.

If there is a requirement to map points from devices provided by Division 25 BAS Contractor, these points are in addition to the 40,000 point allowance in the Division 25 Specification and updated in Addendum.

25 07 22.11.16 - BACnet - Utility Supplied Water Meters 25 09 22.11.23 - Stick Built - Domestic Water Pumps 25 09 22.33.00 - Stick Built - Electric Domestic Heat Pump Water Heaters 25 09 23.21.23 - Stick Built - Hydronic Pumps - Constant Speed 25 09 23.34.16 - Stick Built - Air Handling - Constant Speed Exhaust Fans 25 09 23.73.13 - Stick Built - Air to Air Energy Recovery Equipment 25 09 23.73.13 - Stick Built - UV Lamp Monitors for Central-Station Air-Handling Units 25 09 23.82.33 - Stick Built - Heating Terminal Units 25 15 11.02 - Operator Workstation Software - Reporting Requirements 25 20 21.13.19 - Double Action Pre-Action Fire Panels 25 20 21.22.00 - Clean Agent Fire Suppression System 25 20 21.22.01 - VESDA System 25 20 21.31.13 - Fire Pumps 25 20 22.11.23.13 - Domestic Water Booster Pumps 25 20 23.05.19 - Flow Meters 25 20 23.09.50 - Variable Frequency Drives 25 20 23.21.23 - Hydronic Pumps with Variable Frequency Drives 25 20 23.34.16 - HVAC Fans (Air Handling) with Variable Frequency Drives 25 20 23.36.00 - Air Terminal Units 25 20 23.52.21 - Electric Boilers 25 20 23.64.30 - Water Heat pumps 25 20 23.73.13 - Indoor Central Station AHUs 25 20 23.81.23 - Computer Room Air Conditioners 25 20 23.82.19 - Fan Coils 25 20 23.84.13 - Humidifiers With Water Treatment 25 20 23.85.00 - Air Flow Measuring Stations 25 20 26.09.23 - Lighting Control Devices (Addressable Fixture) 25 20 26.24.13 - Switchboards 25 20 26.24.16 - Panelboards 25 20 26.27.13 - Electricity Metering Equipment 25 20 26.28.16 - Molded Case Circuit Breakers 25 20 26.31.00 - Photovoltaic Energy Equipment 25 20 26.32.13 - Power Generation - Diesel 25 20 26.33.53 - Uninterruptible Power Supplies 25 20 26.33.56 - Emergency Lighting Inverter 25 20 26.36.00 - Automatic Transfer Switches 25 20 26.56.00 - Exterior Lighting Controls 25 20 28.31.11 - JCI/Simplex Fire Detection and Alarm 25 25 23.21.13 - Wired Connection - Glycol Tanks 25 25 23.21.23 - Wired Connection - Sump/Condensate Pumps 25 25 23.81.23 - Wired Connection - CRAC Unit Condensate Pumps 25 25 26.22.00 - Wired Connection - Low Voltage Transformers - Dry Type 25 25 26.43.13 - Wired Connection - SPD (TVSS)

Owner shall provide IP communications from the ROC Facility to the BACnet Object Integration Device.

The Responsibility Matrix provides additional details on Work Responsibilities for each BACnet Interface Device Type



New BACnet/IP drop. Owner will provide IP connection to BACnet Object Integration Device software application installed on the Owner's Virtual Machine.

BACnet Object Integration Device(s)

Division 25 BAS Contractor shall provide a BACnet Object Integration Device software application installed on a VM provided by Owner.

Division 25 BAS Contractor shall map all BACnet objects from the BACnet/IP and BACnet MS/TP devices shown on this BACnet Single Line Diagram to BAS Contractor objects in this Device so graphics, reports, trends, alarms and schedules can be provided.

The software device shall support Als, AOs, AVs, Bls, BOs, BVs, MSIs, MSOs and MSVs. Support for mapping Trend Log, Schedule, Calendar, Notification Class and Event Enrollment Objects is not required if the BAS Contractor creates these objects in the Integration Device or a Division 25 supplied BAS panel.

Allow for a mapping maximum of 40,000 objects of which 5,000 objects maximum, shall be writable.

The BACnet Object Integration Device software application shall support the writing of Present Values to any of the Als, AOs, AVs, Bls, BOs, BVs, MSIs, MSOs and MSVs in the Work of this project.

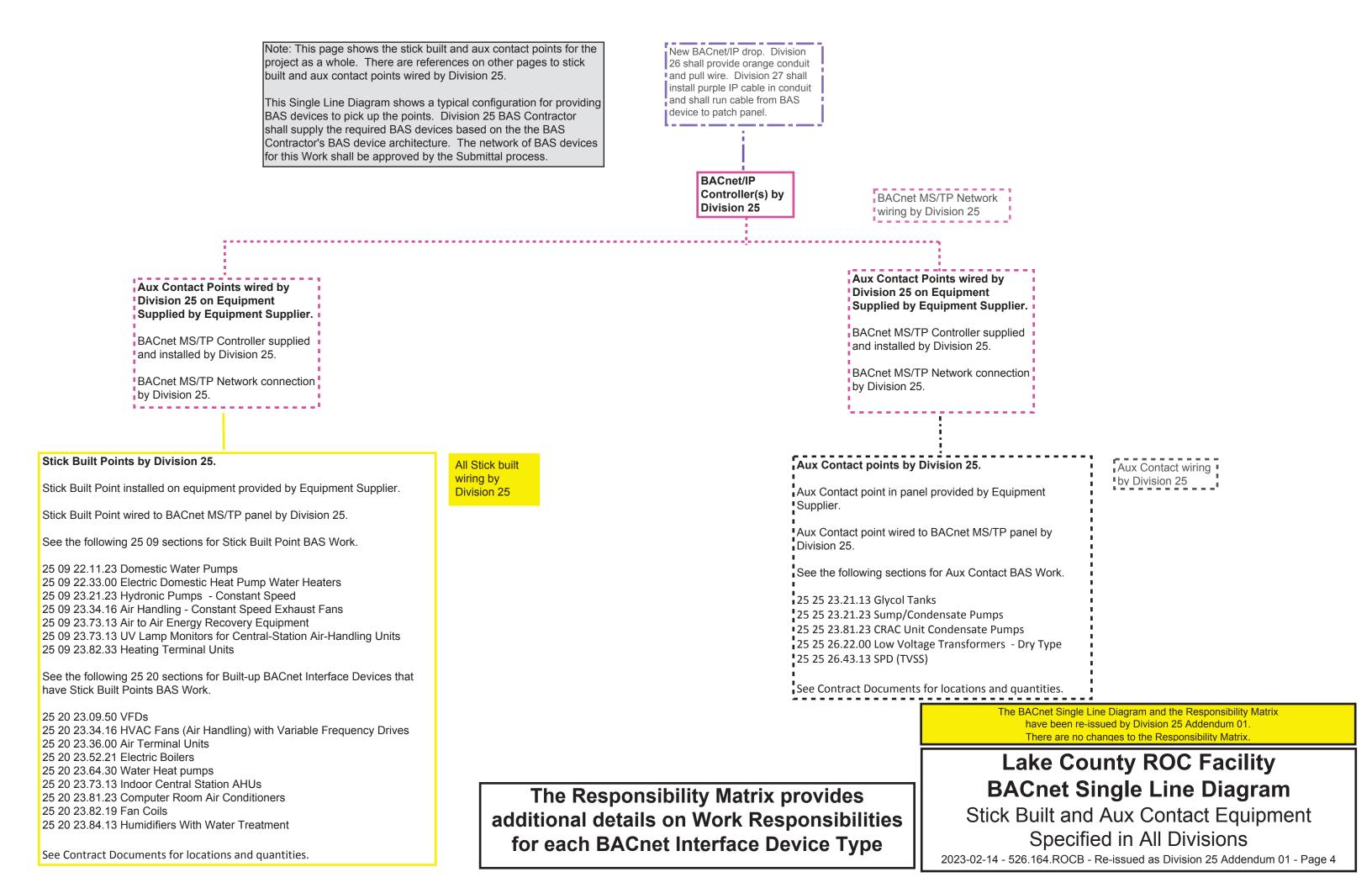
The Owner will spin up multiple VMs if the Division 25 BAS Contractor needs to provide more than than on BACnet Object Integration Device to meet the 40,000 object minimum.

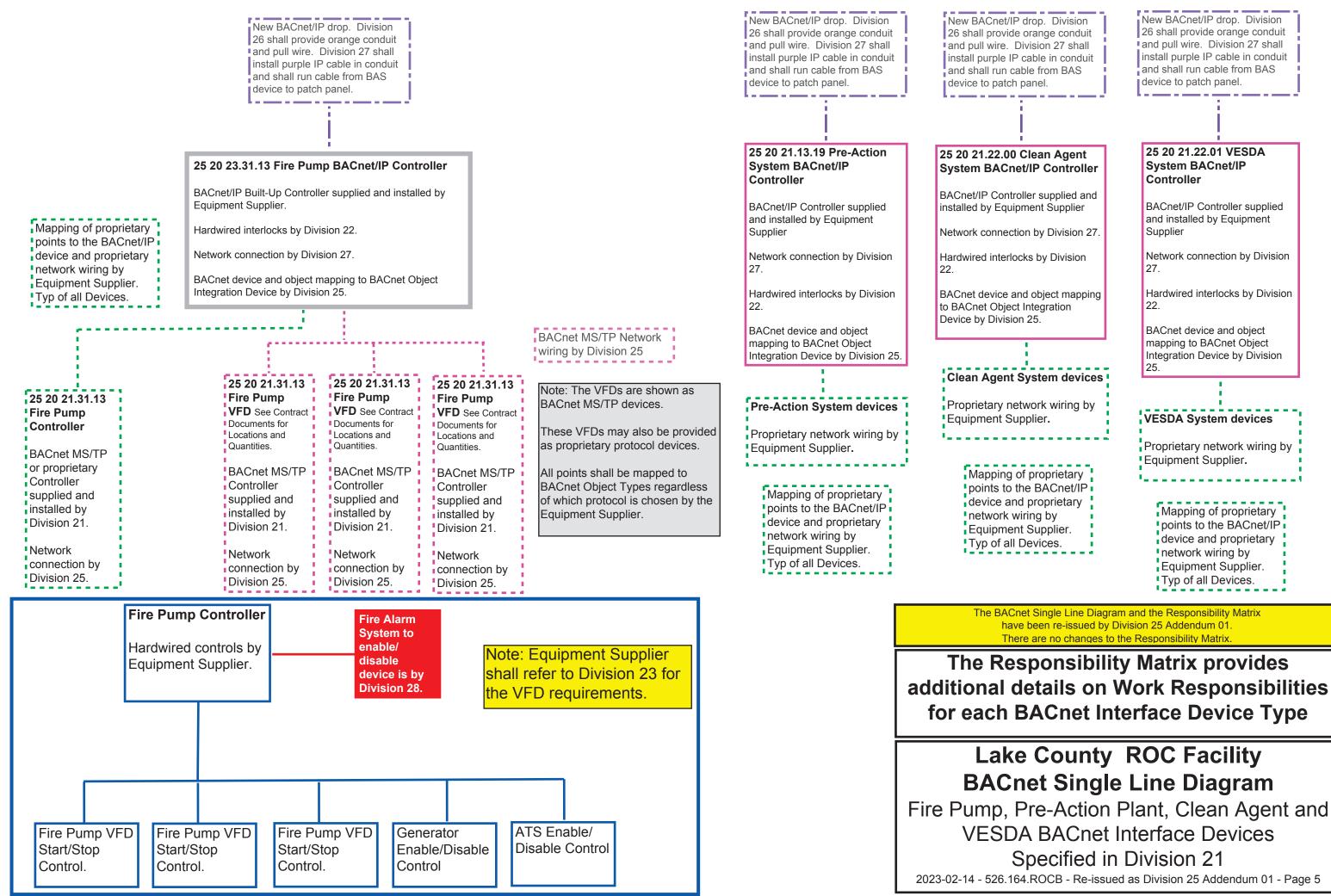
This VM is separate from the VM that the Owner will spin up to host the Division 25 BAS Contractor's Front End and Reporting software application.

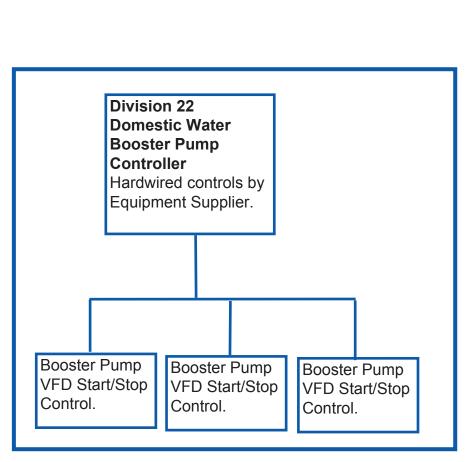
The BACnet Single Line Diagram and the Responsibility Matrix have been re-issued by Division 25 Addendum 01. There are no changes to the Responsibility Matrix.

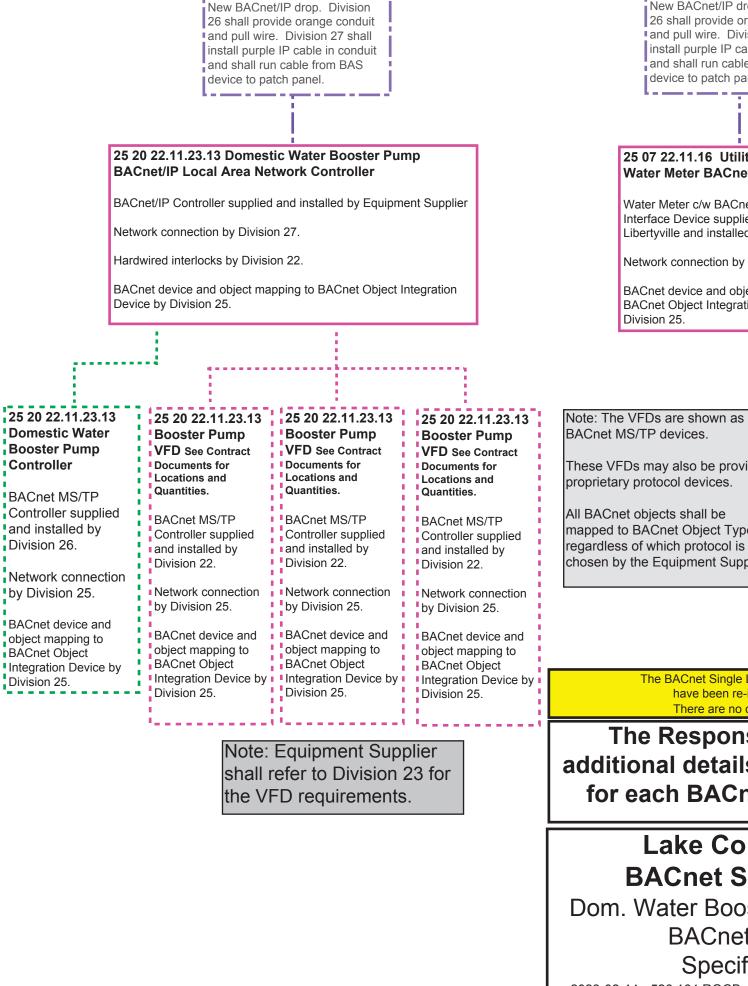
Lake County ROC Facility **BACnet Single Line Diagram BACnet Object Integration Device software** application installed on Owner's VM

2023-02-14 - 526.164.ROCB - Re-issued as Division 25 Addendum 01 - Page 3









New BACnet/IP drop. Division 26 shall provide orange conduit and pull wire. Division 27 shall install purple IP cable in conduit and shall run cable from BAS device to patch panel

25 07 22.11.16 Utility Supplied Water Meter BACnet/IP Controller

Water Meter c/w BACnet/IP BACnet Interface Device supplied by the Village of Libertyville and installed by Division 22.

Network connection by Division 27.

BACnet device and object mapping to BACnet Object Integration Device by

These VFDs may also be provided

mapped to BACnet Object Types chosen by the Equipment Supplier

> The BACnet Single Line Diagram and the Responsibility Matrix have been re-issued by Division 25 Addendum 01. There are no changes to the Responsibility Matrix

The Responsibility Matrix provides additional details on Work Responsibilities for each BACnet Interface Device Type

Lake County ROC Facility **BACnet Single Line Diagram** Dom. Water Booster Pump and Water Meter **BACnet Interface Devices** Specified in Division 22 2023-02-14 - 526.164.ROCB - Re-issued as Division 25 Addendum 01 - Page 6

Each AHU BACnet/IP device shall communicate with each Networked Lighting BACnet/IP device over the Owner's Enterprise LAN.

Lighting Equipment Supplier shall expose the state of the Occupancy/Vacancy Sensors.

Division 25 BAS Contractor shall map the state of the Lighting Systems Occupancy/Vacancy Sensors to BAS panel BVs so as to implement the CA Title 24 Standby Occupancy Sequence of Operations outlined in the Division 25 Specification.

25 20 26.09.23 Networked Lighting **BACnet/IP Controllers**

See Page 9 of the BACnet Single Line Diagram for information on the BACnet/IP Networked Lighting Controllers.

Note: This BACnet Single Line Diagram is typical for each AHU provided in the Work.

New BACnet/IP drop. Division 26 shall provide orange conduit and pull wire. Division 27 shall install purple IP cable in conduit and shall run cable from BAS device to patch panel.

25 20 23.73.13 AHU Plant (three New AHUs all Types)

BACnet/IP Built-Up Controller supplied and installed by Division 25 BAS Contractor.

Network connection by Division 27.

Fire alarm hardwired interlocks by Division 28.

BACnet device and object mapping to BACnet Object Integration Device by Division 25.

Each AHU BACnet/IP device shall communicate with each humidifier BACnet/IP device over the Owner's Enterprise LAN. Division 25 shall send a setpoint and an enable/disable signal and shall receive alarms.

Fire Alarm System nterlocks by Division 28.

25 20 23.09.50 HVAC Fans VFDs (AHU Component) See Contract Documents for Locations and Quantities.

BACnet MS/TP Controller supplied and installed by Division 25 BAS Contractor.

Network connection by Division 25 BAS Contractor.

All VFDs in the Work are provided by Division 25.

BACnet device and object mapping to BACnet Object Integration Device by Division 25.

Stick built AHU VFD points provided by **Division 25 BAS** Contractor Provide the following points:

-VFD enable/disable BO -VFD speed % AO -VFD status BI -VFD Common Alarm BI

Stick built AHU points provided by Division **25 BAS Contractor** See Contract Documents for Locations and

See Division 23 for points to be installed. This includes the Air to Air Energy Recovery Equipment.

Quantities.

Connect all these points to a BACnet MS/TP controller.

Division 25 may use a BACnet/IP device if it supports I/O boards for points.

Page 2 above shows additional stick built points that are required for the AHU Built-up BACnet Interface Device.

BACnet device and object mapping to BACnet Object Integration Device by Division 25.

Note: Division 25 BAS Contractor shall refer

to Division 23 for the VFD requirements.

Stick built AHU Humidifier points provided by Division **25 BAS Contractor** See Contract Documents for Locations and Quantities.

See Division 23 for points to be installed.

Connect all these points to a BACnet MS/TP controller.

Division 25 may use a BACnet/IP device if it supports I/O boards for points.

BACnet device and object mapping to **BACnet Object** Integration Device by Division 25.

25 09 23.73.13 Stick Built connection to UV Lamp Monitors provided by Division 25. See Contract Documents for Locations and Quantities.

Division 25 shall wire to BACnet MS/TP Controller supplied and installed by Division 25.

See Contract Documents for points.

Division 25 may use a BACnet/IP device if it supports I/O boards for points.

BACnet device and object mapping to BACnet Object Integration Device by Division 25.

See 25 20 23.36.00 for Air Terminal Units See Contract Documents for Locations and Quantities.

See 25 20 23.82.19 for Fan Coil Units See Contract Documents for Locations and Quantities.

Division 25 BAS Contractor shall supply BACnet MS/TP controllers for the ATUs and FCUs in the Work. See Division 23 for locations and quantities.

Network connection by Division 25 BAS Contractor.

BACnet device and object mapping to BACnet Object Integration Device by Division 25.

> Stick built ATU and FCU points provided by Division **25 BAS Contractor**

See Division 23 for points to be installed.

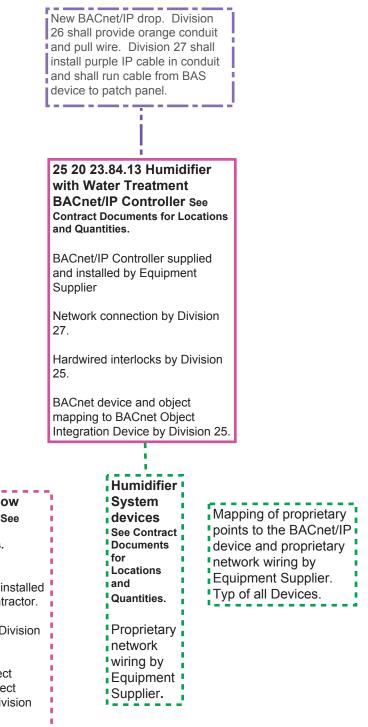
25 20 23.85.00 Air Flow Measuring Stations See Contract Documents for Locations and Quantities.

BACnet MS/TP Controller supplied and installed by Division 25 BAS Contractor.

Network connection by Division 25 BAS Contractor.

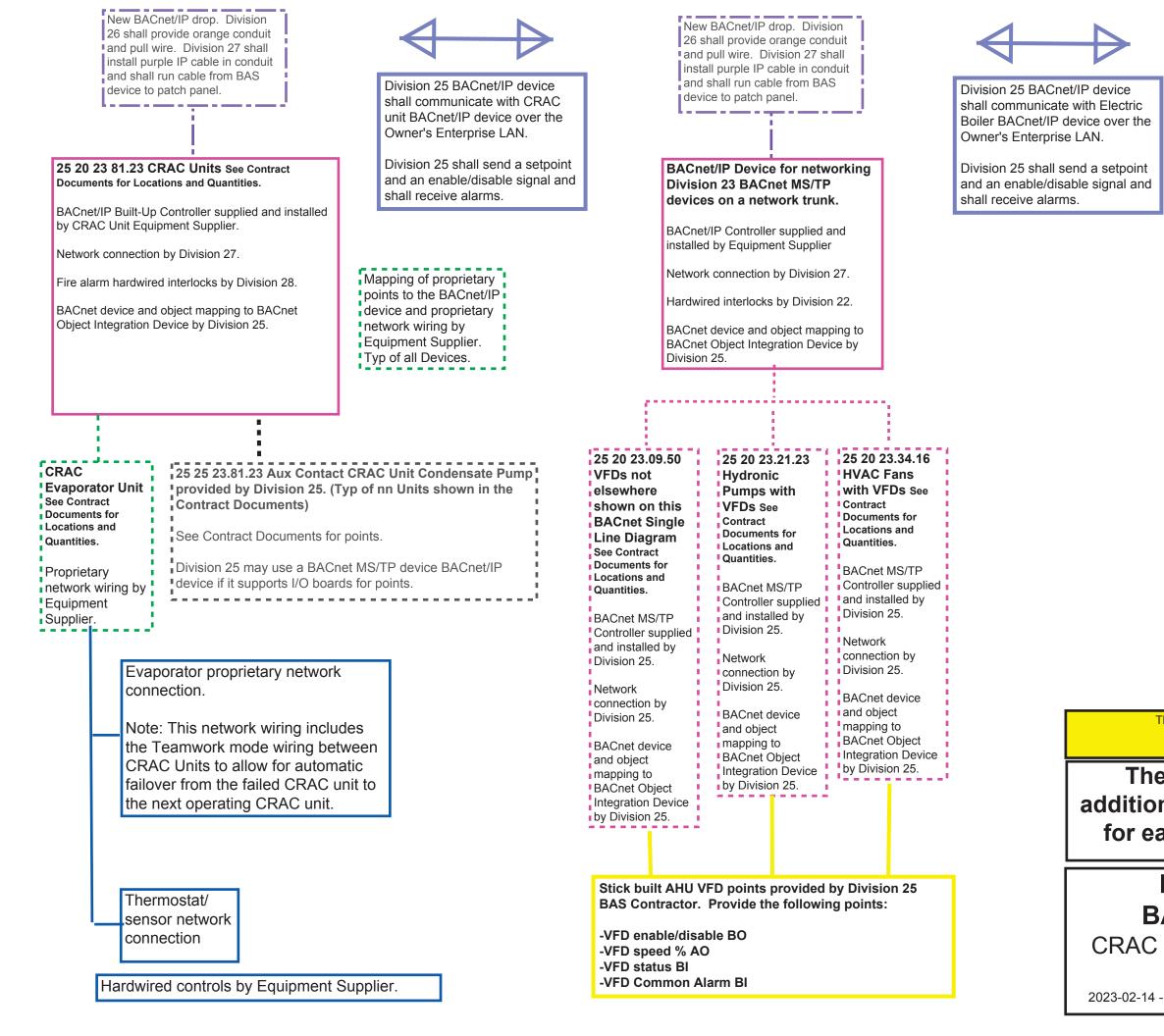
BACnet device and object mapping to BACnet Object Integration Device by Division 25.

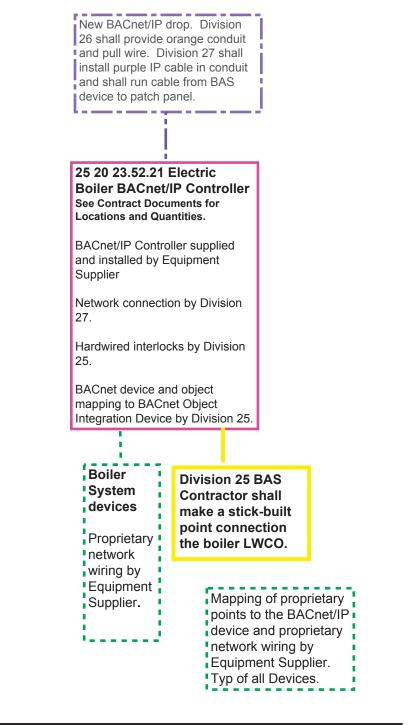
Lake County ROC Facility **BACnet Single Line Diagram AHUs BACnet Interface Devices** Specified in Division 23 2023-02-14 - 526.164.ROCB - Re-issued as Division 25 Addendum 01 - Page 7



The BACnet Single Line Diagram and the Responsibility Matrix have been re-issued by Division 25 Addendum 01. There are no changes to the Responsibility Matrix

The Responsibility Matrix provides additional details on Work Responsibilities for each BACnet Interface Device Type





The BACnet Single Line Diagram and the Responsibility Matrix have been re-issued by Division 25 Addendum 01. There are no changes to the Responsibility Matrix.

The Responsibility Matrix provides additional details on Work Responsibilities for each BACnet Interface Device Type

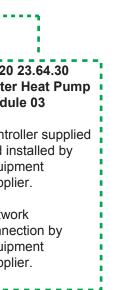
	New BACnet/IP 26 shall provide and pull wire. D install purple IP and shall run cal device to patch	orange conduit ivision 27 shall cable in conduit ble from BAS	Division 25 BACnet/IP d shall communicate with Pump system BACnet/IF over the Owner's Enterp	levice Heat P device	w BACnet/IP drop. Divisio shall provide orange condu d pull wire. Division 27 sha tall purple IP cable in cond d shall run cable from BAS vice to patch panel.	uit all luit					
	BACnet/IP Device for ne BACnet MS/TP devices of BACnet/IP Controller supplie Supplier Network connection by Divisi Hardwired interlocks by Divis	on a network trunk. d and installed by Equipment on 27.		25 20 23.64.30 Water Heat Pump BACnet/IP Controlle Documents for Locations and Quantities. BACnet/IP Controller supplied and installed by Equipment Supplied Network connection by Division 27. Hardwired interlocks by Division 25.							
,	BACnet device and object ma Integration Device by Division	apping to BACnet Object		BACnet device and object r Division 25.	napping to BACnet Object	Integration					
25 20 23.64.30 BACnet MS/TP Controller for Heat Pump System Stick Built and Aux Contact points See Contract Documents for Locations and Quantities. BACnet MS/TP Controller supplied and installed by Division 25. Network connection by Division 25. BACnet device and object mapping to BACnet Object Integration Device by Division 25. 25 25 23.21.13 Aux Contact Glycol Tank Alarm provided by Division 25. See Contract Documents for Locations and Quantities.	Flow Meters See Contract Documents for Locations and Quantities. BACnet MS/TP Controller supplied and installed by Division 25.		Cnet MS/TP Network ng by Division 25.	25 20 23.64.30 Water Heat Pump Module 01 Controller supplied and installed by Equipment Supplier. Network connection by Equipment Supplier.	add	25 20 2 Water Modul Contro and ins Equipn Supplie Supplie The B					
See Contract Documents for points to be installed.						La BA ter He					
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Device by

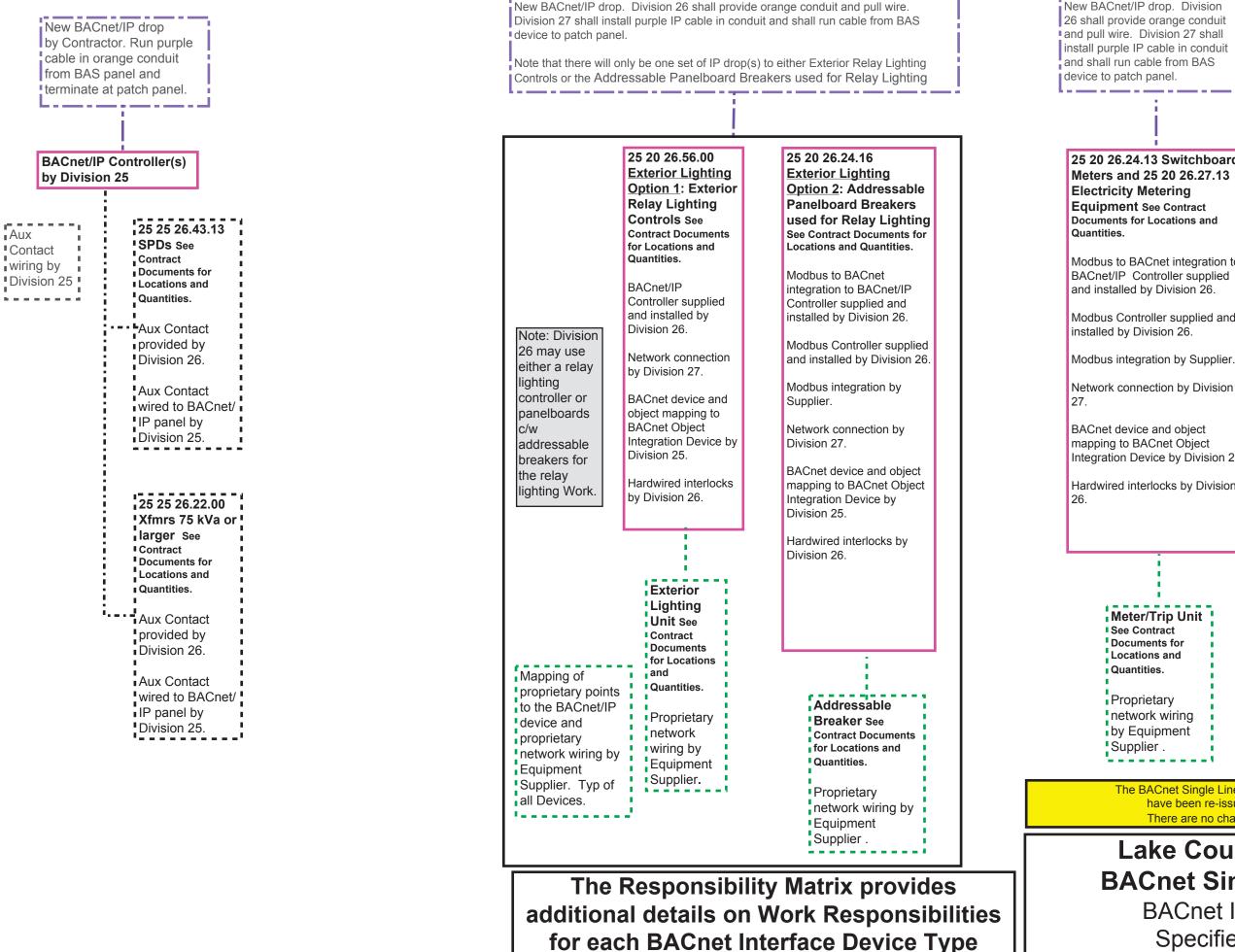
Note: Heat Pump Modules shall come with the necessary hardware and software to all Modules to allow for the automatic failover from the failed Heat Pump module to the next operating Heat Pump module.



Mapping of proprietary points to the BACnet/IP device and proprietary network wiring by Equipment Supplier. Typ of all Devices.

ACnet Single Line Diagram and the Responsibility Matrix have been re-issued by Division 25 Addendum 01. There are no changes to the Responsibility Matrix

Responsibility Matrix provides al details on Work Responsibilities h BACnet Interface Device Type



Aux

New BACnet/IP drop. Division

New BACnet/IP drop. Division 26 shall provide orange conduit and pull wire. Division 27 shall install purple IP cable in conduit and shall run cable from BAS device to patch panel.

25 20 26.24.13 Switchboard

Modbus to BACnet integration to

Modbus Controller supplied and

Integration Device by Division 25.

Hardwired interlocks by Division

Meter/Trip Unit

25 20 26.24.13 Trip Units and 25 20 26.28.16 Trip Units on Circuit Breakers See Contract Documents for Locations and Quantities.

Modbus to BACnet integration to BACnet/ **IP** Controller supplied and installed by Division 26.

Modbus Controller supplied and installed by Division 26.

Modbus integration by Supplier.

Network connection by Division 27.

BACnet device and object mapping to BACnet Object Integration Device by Division 25.

Hardwired interlocks by Division 26.

Trip Units See Contract Documents for Locations and Quantities.

Proprietary network wiring by Equipment Supplier.

Note that separate BACnet/IP devices are shown for each type of device.

Contractor may use one BACnet/IP device so long as the network throughput requirements of the Division 25 spec are met.

These two BACnet Single Line Diagram components also include the Work of 25 20 26.27.13 Electricity Metering Equipment.

Mapping of proprietary points to the BACnet/IP device and proprietary network wiring by Equipment Supplier. See Contract Documents for Locations and Quantities.

The BACnet Single Line Diagram and the Responsibility Matrix have been re-issued by Division 25 Addendum 01 There are no changes to the Responsibility Matrix

Each AHU BACnet/IP device shall communicate with each Networked Lighting BACnet/IP device over the Owner's Enterprise LAN.

Lighting Equipment Supplier shall expose the state of the Occupancy/Vacancy Sensors.

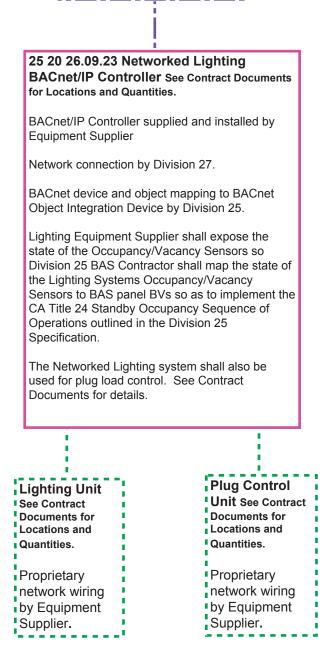
Division 25 BAS Contractor shall map the state of the Lighting Systems Occupancy/Vacancy Sensors to BAS panel BVs so as to implement the CA Title 24 Standby Occupancy Sequence of Operations outlined in the Division 25 Specification.

25 20 23.73.13 AHU Plant (three New AHUs all Types)

See Page 6 of the BACnet Single Line Diagram for information on the BACnet/IP AHU Controllers.

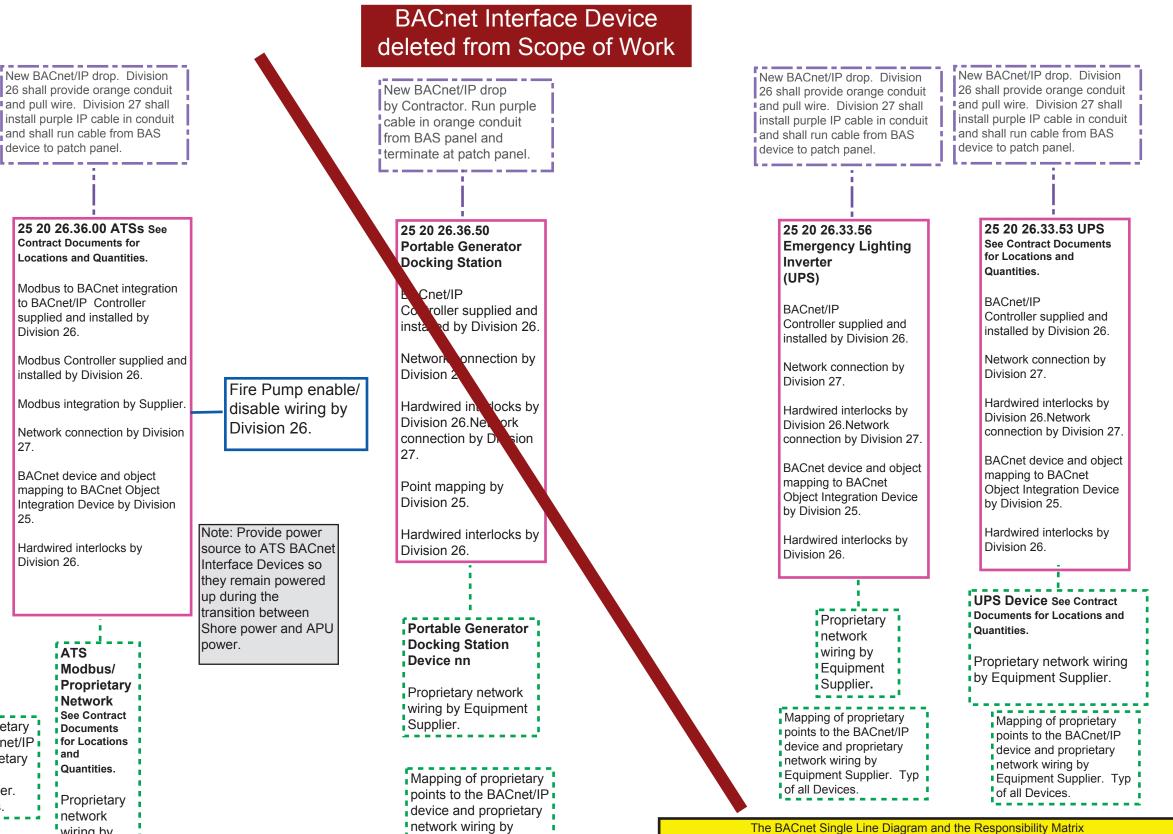


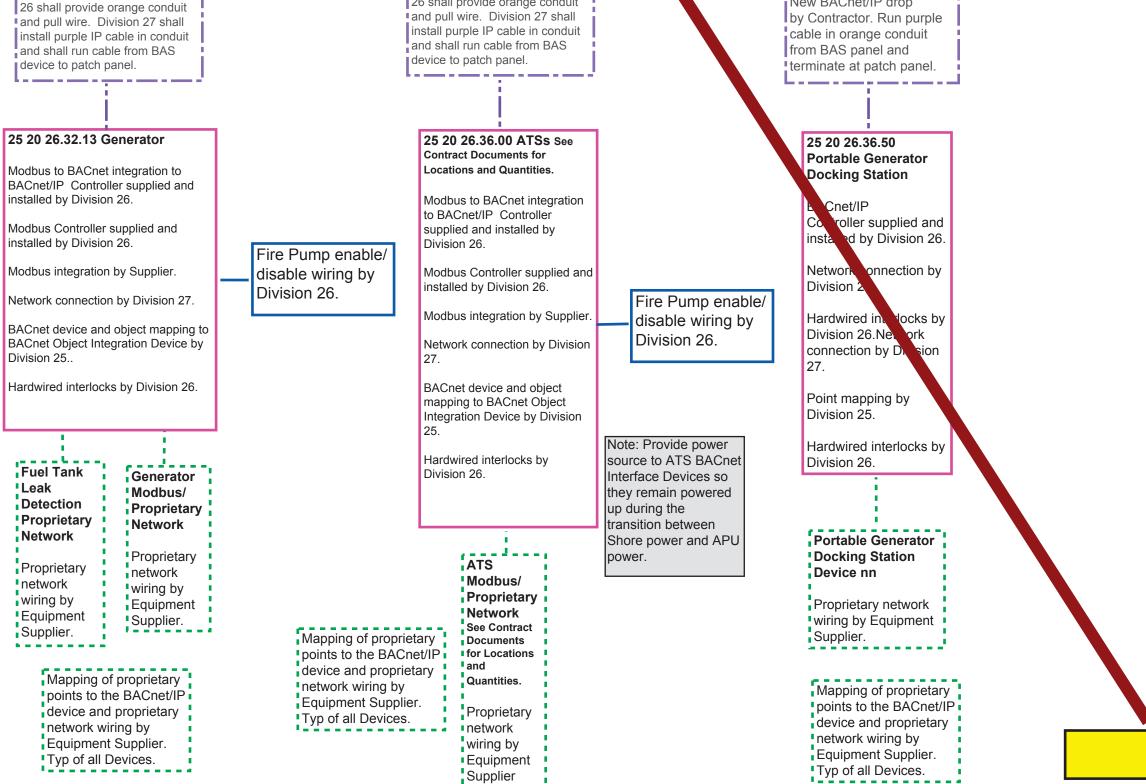
New BACnet/IP drop. Division 26 shall provide orange conduit and pull wire. Division 27 shall install purple IP cable in conduit and shall run cable from BAS device to patch panel.



The Responsibility Matrix provides additional details on Work Responsibilities for each BACnet Interface Device Type

The BACnet Single Line Diagram and the Responsibility Matrix have been re-issued by Division 25 Addendum 01. There are no changes to the Responsibility Matrix

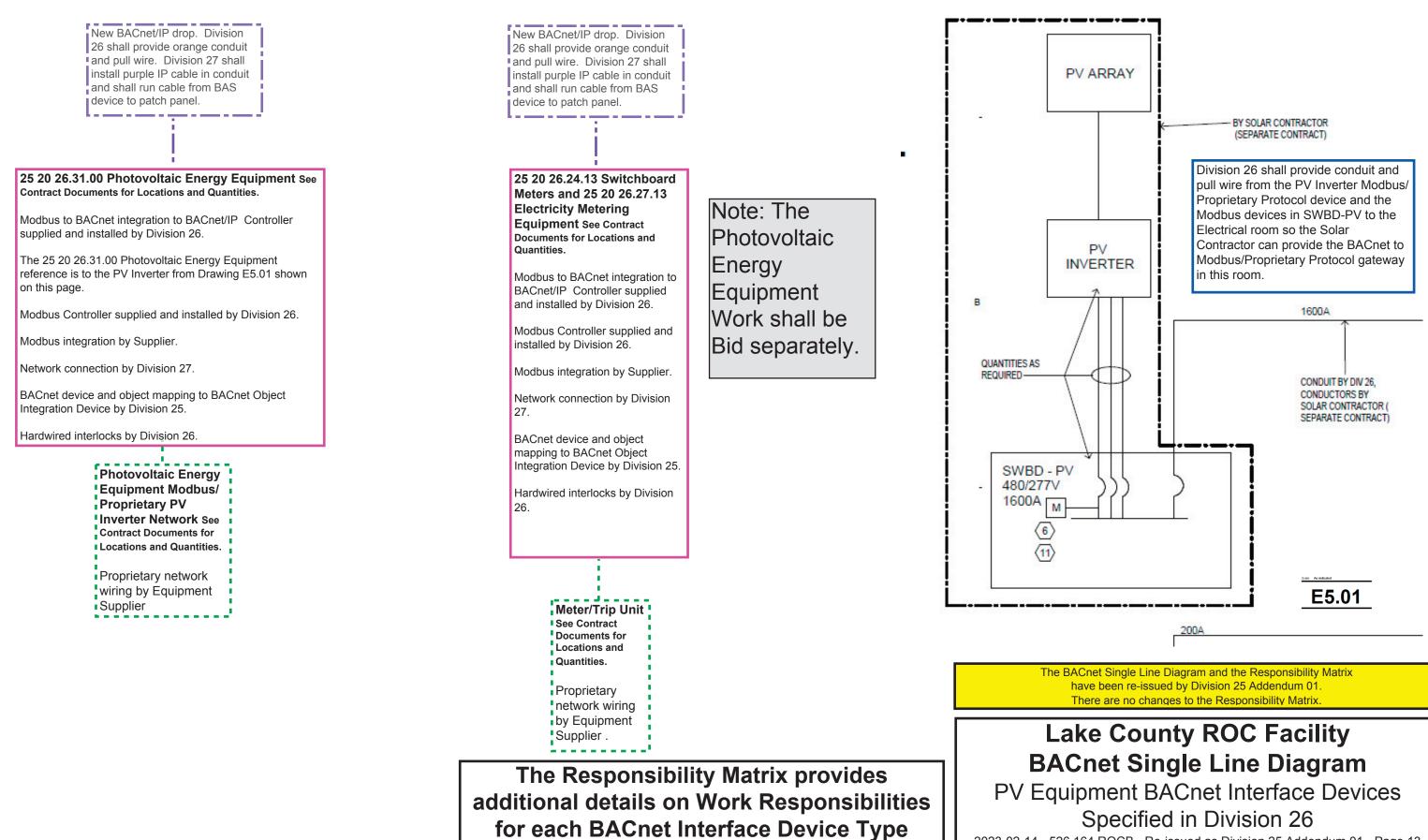




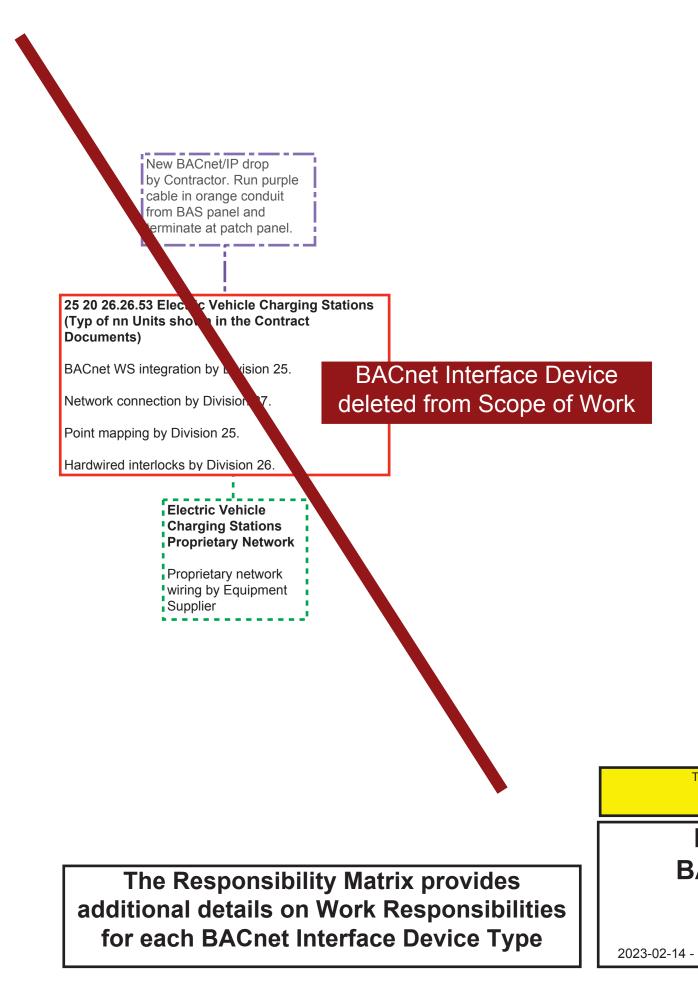
New BACnet/IP drop. Division

The Responsibility Matrix provides additional details on Work Responsibilities for each BACnet Interface Device Type

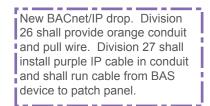
have been re-issued by Division 25 Addendum 01 There are no changes to the Responsibility Matrix



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The BACnet Single Line Diagram and the Responsibility Matrix have been re-issued by Division 25 Addendum 01. There are no changes to the Responsibility Matrix.



25 20 28.31.13 Fire Alarm See Contract Documents for Locations and Quantities.

UL Listed BACnet/IP Controller supplied and installed by Division 28.

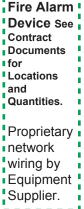
This Work will be done by Simplex.

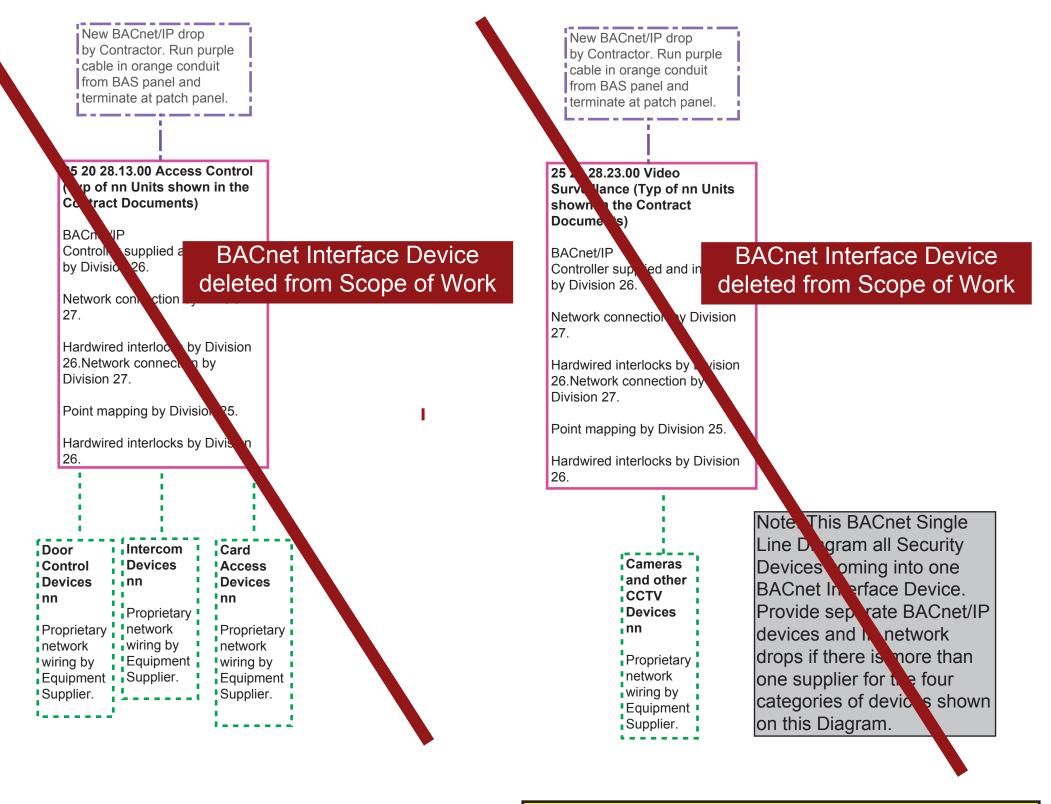
Network connection by Division 27

Hardwired interlocks by Division 28

BACnet device and object mapping to BACnet Object Integration Device by Division 25

Mapping of proprietary points to the BACnet/IP device and proprietary network wiring by Equipment Supplier. Typ of all Devices.	Fil De Co Do for Lo Qu
	Pro





The Responsibility Matrix provides additional details on Work Responsibilities for each BACnet Interface Device Type



The BACnet Single Line Diagram and the Responsibility Matrix have been re-issued by Division 25 Addendum 01 There are no changes to the Responsibility Matrix

Work Item	Construction Management					Power Wiring			Communication Wiring			Software & Programming			
Responsibility Matrix: BAS Administration (Applies to all BACnet Device Types and all aspects of the Work) See Section 25 00 13 for definitions.	Submit documentation for approval	Participate/ Provide Assistance	Furnish (or provide device)	Install	Commission	Safety and Interlock wiring	From the Panelboard to the Power Drop	From the Power Drop to the Device	From the Supplier's Equipment	From the BACnet Device to the local Equipment	From the BAS to the BACnet Device	BAS Network Connection	BACnet Interface Device	Supplier's Equipment	Supervisory Control
Provide permits and/or pay fees for permits if required by the Authority Having Jurisdiction or per Specification.	General Contractor	General Contractor	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Provide special approval if required by the Authority Having Jurisdiction or per Specification	General Contractor	General Contractor	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Provide special testing reports per Specification	General Contractor	General Contractor	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Attend Co-ordination Meeting per Division 25 07 nn, 25 20 nn, 25 09 nn, 25 20 nn and 25 25 nn Sections (nn refers to the sections included in the Division 25 Specification)	Equipment Supplier, Mechanical Contractor, Electrical Contractor	Equipment Supplier, Mechanical Contractor, Electrical Contractor	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Provide submittals to Owner per Specification.	All Divisions	All Divisions	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Submit a Project Work Plan to Owner per Specification.	25	25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Assist TAB in equipment set-up per Specification.	25	25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Commissioning BAS and BACnet Interface Device per Division 25 Commissioning Section or per Specification.	All Divisions	All Divisions	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Commissioning BAS and BACnet Interface Device integration to meet Enhanced Commissioning requirements (LEED).	All Divisions	All Divisions	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Note E.S. means Equipment Supplier. Div means Division. N/A means not applicable.															

Work Item	Construction	Management					Power Wiring			Communication ⁷	Wiring		Software and	Programming	
<u>Responsibility Matrix</u>: BAS and BACnet Interface Device IP and non-IP Infrastructure. See Section 25 00 13 for definitions.	Submit documentation for approval	Participate/ Provide Assistance	Furnish (or provide device)	Install	Commission	Safety and Interlock wiring	From the Panelboard to the Power Drop	From the Power Drop to the Device	From the Supplier's Equipment	From the BACnet Device to the local Equipment	From the BAS to the BACnet Device	BAS Network Connection	BACnet Interface Device	Supplier's Equipment	Supervisory Control
IP switches used solely for the installation and networking of devices used to make the BACnet Internetwork operational (excluding devices used to provide connectivity to the Owner's Intranet).	27	Owner, GC, 25, 26, 27	27	27	27	N/A	26	26	26	27	27	27			Owner
IP network cable used solely for the installation and networking of devices used to make the BACnet Internetwork operational (excluding network cable used to provide connectivity to the Owner's Intranet).	27	Owner, GC, 25, 26, 27	27	27	27	N/A	N/A	N/A	N/A	27	27	27	27 to test cable	27 to test cable	27 to test cable
MS/TP network cable used solely for the installation and networking of devices used to make the BACnet MS/TP trunk operational.	25	25	25	25	25	N/A	N/A	N/A	N/A	25	25	25	25	25	25
ARCNET, LonTalk or vendor proprietary network cable used solely for the installation and networking of devices used to make the device network operational.	Device Equipment Supplier	Device Equipment Supplier	Device Equipment Supplier	Device Equipment Supplier	Device Equipment Supplier	N/A	N/A	N/A	N/A	Device Equipment Supplier	Device Equipment Supplier	Device Equipment Supplier	Device Equipment Supplier	Device Equipment Supplier	Device Equipment Supplier
IP network cable terminations to the patch panel located in the IDF/MDF Rooms or Communications Closet.	Owner	Owner, GC, 25, 26, 27	Owner	Owner	Owner	N/A	N/A	N/A	N/A	Owner and 27	Owner and 27	Owner and 27	Owner and 27	Owner and 27	Owner and 27
IP switches and switch connections from the Owner's Intranet to one or more BACnet Internetworks.	Owner	Owner, GC, 25, 26, 27	Owner	Owner	Owner	N/A	26	26	26	Owner and 27	Owner and 27	Owner and 27	Owner and 27	Owner and 27	Owner and 27
Provision of IPv4, IPv6 addresses, Subnet mask, default gateway, preferred DNS, alternate DNS.	Owner	Owner, GC, 25, 26, 27	Owner	Owner	Owner	N/A	N/A	N/A	N/A	Owner and 27	Owner and 27	Owner and 27	Owner and 27	Owner and 27	Owner and 27
Account setup to access BAS software applications on the server(s).	Owner	Owner, GC, 25, 26, 27	Owner	Owner	Owner	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Owner	Owner	Owner
Account setup to access BACnet/IP devices.	Division supplying the equipment	Owner, GC, 25, 26, 27	Division supplying the equipment	Division supplying the equipment	Owner, GC, 25, 26, 27	N/A	N/A	N/A	N/A	Owner and 25	Owner and 25	Owner and 25	Owner and 25	Owner and 25	Owner and 25
Account setup to access BACnet MS/TP devices.	25	Owner, GC, 25, 26, 27	25	25	25	N/A	N/A	N/A	N/A	Owner and 25	Owner and 25	Owner and 25	Owner and 25	Owner and 25	Owner and 25
Front End Software	Division supplying the equipment	Division supplying the equipment	Division supplying the equipment	Division supplying the equipment	Division supplying the equipment	N/A	N/A	N/A	N/A	Division supplying the equipment	Division supplying the equipment	Division supplying the equipment	Division supplying the equipment	Division supplying the equipment	Division Supplying the Equipment
Virtual Machine for Front End Software	Owner	Owner	Owner	Owner	Owner	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Owner	Owner	Owner
The Owner is the Lake County															

Work Item	Construction	Management					Power Wiring			Communication '	Wiring		Software and	Programming	
Responsibility Matrix: BAS and BACnet Interface Device IP and non-IP Infrastructure. See Section 25 00 13 for definitions.	Submit documentation for approval	Participate/ Provide Assistance	Furnish (or provide device)	Install	Commission	Safety and Interlock wiring	From the Panelboard to the Power Drop	From the Power Drop to the Device	From the Supplier's Equipment	From the BACnet Device to the local Equipment	From the BAS to the BACnet Device	BAS Network Connection	BACnet Interface Device	Supplier's Equipment	Supervisory Control
Specific Division refers to the Division that provided the device.															
Power drops to be within 1 m (3 ft.) of the device.															

Work Item	Construction N	Aanagement				Power Wiring	2			Communica	tion Wiring		Software and	Programming	
Responsibility Matrix: Built- Up BACnet Interface Device Option. See Section 25 00 13 for definitions.	Submit documentation for approval	Participate/ Provide Assistance	Furnish (or provide device)	Install	Commission	Safety and Interlock wiring	From the Panelboard to the Power Drop	From the Power Drop to the Device	From the Supplier's Equipment	From the BACnet Device to the local Equipment	From the BAS to the BACnet Device	BAS Network Connection	BACnet Interface Device	Supplier's Equipment	Supervisory Control
Native BACnet device (all data link/network layer options) required to make the supplier's equipment operational and networkable to the BACnet Internetwork.	Specific Division	Specific Division	Specific Division	-	Specific Division	Specific Division	26	26	26	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	Specific Division	Specific Division	25
BACnet Interface Device required to convert proprietary protocols and to map proprietary data points/ register values resident in the supplier's equipment control panel to BACnet AV, BV or other Object Types so the BACnet Interface Device will make the supplier's equipment operational and will present to the BACnet Internetwork as a Native BACnet device.	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	26	26	26	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	Specific Division	Specific Division	25
Any proprietary (non-BACnet) software, computer, printer, cables, USB keys or any other devices required to make the supplier's equipment operational.	Specific Division	Specific Division	Specific Division		Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division
Provide programming or configuration of the supplier's control panel and/or BACnet Interface Device to meet the Sequence of Operations.	Specific Division	Specific Division		Specific Division	Specific Division	N/A	Specific Division	Specific Division	Specific Division						
Provide control, graphics, trends, alarms, schedules for this BACnet Interface Device on the BACnet Internetwork.	ALC	ALC	ALC	ALC	ALC	ALC	ALC	ALC	ALC	ALC	ALC	ALC	ALC	ALC	ALC
Network connection to the BACnet Internetwork.	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	P and 25 for	27 for BACnet/I P and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	Specific Division	Specific Division	Specific Division						
Any equipment shipped loose or required to be supplied by others to make the supplier's equipment operational.	Specific Division	Specific Division	Specific Division	Specific Division		Specific Division	26	26	26	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division
Equipment control panel(s) integral to supplier's equipment. Integral means that the panel is supplied and installed with the equipment and is powered from a single point of connection. Note that this includes equipment provided by the supplier but may be an OEM panel. Note that this does not include the BACnet Interface Device.	Specific Division	Specific Division	Specific Division	Specific	Specific Division	Specific Division	26	26	26	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division
Equipment control panels NOT integral to supplier's equipment. Note that this includes equipment provided by the supplier but may be an OEM panel. Note that this does not include the BACnet Interface Device.	Specific Division	Specific Division	Specific Division	-	Specific Division	Specific Division	26	26	26	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division
Control panel and BAS device housings and enclosures (Including backboards attached to walls or free standing uni-strut structures).	Specific Division	Specific Division	Specific Division	-	Specific Division	Specific Division	26	26	26	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division
Variable Speed Drive and other BACnet MS/TP devices integral to supplied equipment excluding power wiring.	26	26	Specific Division	Specific Division	Specific Division	Specific Division	26	26	26	Specific Division	25	27 for BACnet/IP and 25 for BACnet MS/TP	Specific Division	Specific Division	25

Work Item	Construction 1	Management				Power Wiring	5			Communica	tion Wiring		Software and	Programming	
<u>Responsibility Matrix</u>: Built- Up BACnet Interface Device Option. See Section 25 00 13 for definitions.	Submit documentation for approval	Participate/ Provide Assistance	Furnish (or provide device)	Install	Commission	Safety and Interlock wiring	From the Panelboard to the Power Drop	From the Power Drop to the Device	From the Supplier's Equipment	From the BACnet Device to the local Equipment	From the BAS to the BACnet Device	BAS Network Connection	BACnet Interface Device	Supplier's Equipment	Supervisory Control
Variable Speed Drive and other BACnet MS/TP devices separate to supplied equipment excluding power wiring.	26	26	26	26	26	26	26	26	26	Specific Division	25	27 for BACnet/IP and 25 for BACnet MS/TP	Specific Division	Specific Division	25
Power wiring for fan or pump Variable Speed Drive.	26	26	26	26	26	26	26	26	26	N/A	N/A	N/A	N/A	N/A	N/A
Any power wiring for any external valve(s), damper(s), sensor(s), meter(s), transducer(s) or any other device(s)	26	26	26	26	26	26	26	25	26	N/A	N/A	N/A	N/A	N/A	N/A
Any valve(s), damper(s), sensor(s), meter(s), transducer(s) or any other device(s) required to make the supplier's equipment operational. This includes devices that are called up in the Contract Documents as <u>being external</u> to the supplier's equipment.	25	25	25	25	25 and Specific Division	26	26	25	26	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	Specific Division	Specific Division	25
Any valve(s), damper(s), sensor(s), meter(s), transducer(s) or any other device(s) required to make the supplier's equipment operational. This includes devices that are called up as being <u>supplied with the supplier's equipment with or</u> <u>shipped loose</u> equipment in the Contract Documents.	Specific Division	Specific Division	Specific Division	Specific Division	25 and Specific Division	26	26	25	26	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	Specific Division	Specific Division	25
Any wiring between any valve(s), damper(s), sensor(s), meter(s), transducer(s) or any other device(s) to the supplier's control panel required to make the supplier's equipment operational.	25	25	25	25	25	25	26	25	26	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	Specific Division	Specific Division	25
Any wiring between the BACnet Interface Device and the supplier's control	Specific	Specific	Specific		Specific		26	25	26	Specific	Specific	Specific	Specific	Specific	25
panel and/or equipment. Line or low voltage wiring from the BAS panel to the starter or point of	Division	Division	Division	Division	Division					Division	Division	Division	Division	Division	
connection for controlling the supplier's equipment	25	25	25	25	25	25	26	25	25	N/A	N/A	N/A	25	25	25
Breakers in panelboards required for BAS devices of all types	26	26	26	26	26	26	26	26	26	N/A	N/A	N/A	26	26	26
Starters/HOAs	26	26	26	26	26	26	26	26	26	N/A	N/A	N/A	26	26	26
Line of sight disconnect switches	26	26	26	26	26	26	26	26	26	N/A	N/A	N/A	26	26	26
Line to low voltage transformers	25	25	25	25	25	26	26	26	26	N/A	N/A	N/A	26	26	26
Duct Smoke Detectors	26	26	26	26	26	26	26	26	26	N/A	N/A	N/A	26	26	26
Safety/high limit wiring	25	25	25	25	25	26	26	26	26	N/A	N/A	N/A	26	26	26
LAN connection between the BACnet Interface Device and other BACnet devices that are considered subpanels. The LAN connection may use any BACnet or any proprietary protocol.	Specific Division	Specific Division	Specific Division		Specific Division	27 for BACnet/IP and 25 for BACnet MS/TP	26	26	26	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	Specific Division	Specific Division	25

Up BACnet Interface Device Option. See Section 25 00 13 for definitions. under u	Work Item	Construction N	Aanagement				Power Wiring	5			Communica	tion Wiring		Software and	Programming	
Vertwork connection between the BACnet II therefore Device and the BACnet 25 <	Responsibility Matrix: Built- Up BACnet Interface Device Option. See Section 25 00 13 for definitions.	Submit documentation for approval	Participate/ Provide Assistance	Furnish (or provide device)	Install	Commission	Safety and Interlock wiring	the Panelboard to Power Drop	the Power Drop the Device	From the Supplier's Equipment	3ACnet Device al Equipment	From the BAS to the BACnet Device	Network	BACnet Interface Device	Supplier's Equipment	Supervisory Control
VAV box controllers not including power for the fan in a fan powered VAV 25 26 25 26 25 26 25 26 25 26 <th2< td=""><td>Network connection between the BACnet Interface Device and the BACnet Internetwork.</td><td>25</td><td>25</td><td>25</td><td>25</td><td>25</td><td>BACnet/IP and 25 for BACnet</td><td></td><td>26</td><td>26</td><td>BACnet/IP and 25 for BACnet</td><td>BACnet/IP and 25 for BACnet</td><td>BACnet/IP and 25 for BACnet</td><td></td><td></td><td>25</td></th2<>	Network connection between the BACnet Interface Device and the BACnet Internetwork.	25	25	25	25	25	BACnet/IP and 25 for BACnet		26	26	BACnet/IP and 25 for BACnet	BACnet/IP and 25 for BACnet	BACnet/IP and 25 for BACnet			25
Networkable sensors/controllers for VAV boxes 26 26 26 26 26 26 26 26	VAV box controllers not including power for the fan in a fan powered VAV box.	25	25	26	25	Specific	25	26	25	26	BACnet/IP and 25 for BACnet	BACnet/IP and 25 for BACnet	BACnet/IP and 25 for BACnet	25		
Networkable sensors/controllers for VAV boxes 26 26 26 26 26 26 26 26 26 26 26 26 26	Power wiring for fans in a fan powered VAV box.	26	26	26	26	26	26	26	26	26	N/A	N/A	N/A	N/A	N/A	
Networkable occupancy sensors (all other applications). 26 26 26 26 26 26 26 26	Networkable sensors/controllers for VAV boxes	26	26	25	26	26	26	26	25	26	BACnet/IP and 25 for BACnet	BACnet/IP and 25 for BACnet	BACnet/IP and 25 for BACnet	1	1	
	Networkable occupancy sensors (all other applications).	26	26	26	26	26	26	26	25	26	BACnet/IP and 25 for BACnet	BACnet/IP and 25 for BACnet	BACnet/IP and 25 for BACnet			25
	Spacific Division refers to the Division that provided the device															
	Power drops to be within 1 m (3 ft.) of the device.															

Work Item	Construction	Management						Power Wiring			unication Wirin	g	Software and	Programming	
<u>Responsibility Matrix</u>: Plant Controller BACnet Interface Device Option. See Section 25 00 13 for definitions.	Submit documentation for approval	Participate/ Provide Assistance	Furnish (or provide device)	Install	Commission	Safety and Interlock wiring	From the Panelboard to the Power Drop	From the Power Drop to the Device	From the Supplier's Equipment	From the BACnet Device to the local Equipment	From the BAS to the BACnet Device	BAS Network Connection	BACnet Interface Device	Supplier's Equipment	Supervisory Control
Native BACnet device (all data link/network layer options) required to make the supplier's equipment operational and networkable to the BACnet Internetwork.	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	26	26	26	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	Specific Division	Specific Division	25
BACnet Interface Device required to convert proprietary protocols and to map proprietary data points/ register values resident in the supplier's equipment control panel to BACnet AV, BV or other Object Types so the BACnet Interface Device will make the supplier's equipment operational and will present to the BACnet Internetwork as a Native BACnet device.	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	26	26	26	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	Specific Division	Specific Division	25
Any proprietary (non-BACnet) software, computer, printer, cables, USB keys or any other devices required to make the supplier's equipment operational.	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division
Provide programming or configuration of the supplier's control panel and/or BACnet Interface Device to meet the Sequence of Operations.	Specific Division	Specific Division		Specific Division	Specific Division	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Specific Division	Specific Division	Specific Division
Provide control, graphics, trends, alarms, schedules for this BACnet Interface Device on the BACnet Internetwork.	25	25	25	25	25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	25	25	25
Network connection to the BACnet Internetwork.	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP		27 for BACnet/I P and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	Specific Division	Specific Division	Specific Division
Any equipment shipped loose or required to be supplied by others to make the supplier's equipment operational.	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	26	26	26	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division
Equipment control panel(s) integral to supplier's equipment. Integral means that the panel is supplied and installed with the equipment and is powered from a single point of connection. Note that this includes equipment provided by the supplier but may be an OEM panel. Note that this does not include the BACnet Interface Device.	Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	26	26	26	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division
Equipment control panels NOT integral to supplier's equipment. Note that this includes equipment provided by the supplier but may be an OEM panel. Note that this does not include the BACnet Interface Device.	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	26	26	26	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division
Control panel and BAS device housings and enclosures (Including backboards attached to walls or free standing uni-strut structures).	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division		26	26	26	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division

Work Item	Construction	Management	t					Power Wiring			unication Wirin	g	Software and	Programming	
Responsibility Matrix: Plant Controller BACnet Interface Device Option. See Section 25 00 13 for definitions.	Submit documentation for approval	Participate/ Provide Assistance	Furnish (or provide device)	Install	Commission	Safety and Interlock wiring	From the Panelboard to the Power Drop	From the Power Drop to the Device	From the Supplier's Equipment	From the BACnet Device to the local Equipment	From the BAS to the BACnet Device	BAS Network Connection	BACnet Interface Device	Supplier's Equipment	Supervisory Control
Variable Speed Drive integral to supplied equipment excluding power wiring.	26	26	Specific Division	Specific Division	Specific Division	Specific Division	26	26	26	Specific Division	25	27 for BACnet/IP and 25 for BACnet MS/TP	Specific Division	Specific Division	25
Variable Speed Drive separate to supplied equipment excluding power wiring.	26	26	26	26	26	26	26	26	26	Specific Division	25	27 for BACnet/IP and 25 for BACnet MS/TP	Specific Division	Specific Division	25
Power wiring for fan or pump Variable Speed Drive.	26	26	26	26	26	26	26	26	26	N/A	N/A	N/A	N/A	N/A	N/A
Any power wiring for any external valve(s), damper(s), sensor(s), meter(s), transducer(s) or any other device(s)	26	26	26	26	26	26	26	25	26	N/A	N/A	N/A	N/A	N/A	N/A
Any valve(s), damper(s), sensor(s), meter(s), transducer(s) or any other device(s) required to make the supplier's equipment operational. This includes devices that are called up in the Contract Documents as <u>being external</u> to the supplier's equipment.	25	25	25	25	25 and Specific Division	26	26	25	26	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	Specific Division	Specific Division	25
Any valve(s), damper(s), sensor(s), meter(s), transducer(s) or any other device(s) required to make the supplier's equipment operational. This includes devices that are called up as being <u>supplied with the supplier's equipment with or shipped loose</u> equipment in the Contract Documents.	Specific Division	Specific Division	Specific Division	Specific Division	25 and Specific Division	26	26	25	26	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	Specific Division	Specific Division	25
Any wiring between any valve(s), damper(s), sensor(s), meter(s), transducer(s) or any other device(s) to the supplier's control panel required to make the supplier's equipment operational.	25	25	25	25	25	25	26	25	26	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	Specific Division	Specific Division	25
Any wiring between the BACnet Interface Device and the supplier's	Specific Division	Specific	Specific Division	Specific Division	Specific Division		26	25	26	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	25
control panel and/or equipment. Line or low voltage wiring from the BAS panel to the starter or point of connection for controlling the supplier's equipment	25	Division 25	25	25	25	25	26	25	25	N/A	N/A	N/A	25	25	25
Breakers in panelboards required for BAS devices of all types	26	26	26	26	26	26	26	26	26	N/A	N/A	N/A	26	26	26
Starters/HOAs	26	26	26	26	26	26	26	26	26	N/A	N/A	N/A	26	26	26
Line of sight disconnect switches	26	26	26	26	26	26	26	26	26	N/A	N/A	N/A	26	26	26
Line to low voltage transformers	25	25	25	25	25	26	26	26	26	N/A	N/A	N/A	26	26	26
Duct Smoke Detectors	26	26	26	26	26	26	26	26	26	N/A	N/A	N/A	26	26	26
Safety/high limit wiring	25	25	25	25	25	26	26	26	26	N/A	N/A	N/A	26	26	26

Work Item	Construction	Management	,					Power Wiring		Commu	inication Wirin	g	Software and	Programming	
<u>Responsibility Matrix</u>: Plant Controller BACnet Interface Device Option. See Section 25 00 13 for definitions.	Submit documentation for approval	Participate/ Provide Assistance	Furnish (or provide device)	Install	Commission	Safety and Interlock wiring	From the Panelboard to the Power Drop	From the Power Drop to the Device	From the Supplier's Equipment	From the BACnet Device to the local Equipment	From the BAS to the BACnet Device	BAS Network Connection	BACnet Interface Device	Supplier's Equipment	Supervisory Control
LAN connection between the BACnet Interface Device and other BACnet devices that are considered subpanels. The LAN connection may use any BACnet or any proprietary protocol.	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	27 for BACnet/IP and 25 for BACnet MS/TP	26	26	26	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	Specific Division	Specific Division	25
Network connection between the BACnet Interface Device and the BACnet Internetwork.	25	25	25	25	25	27 for BACnet/IP and 25 for BACnet MS/TP	26	26	26	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	Specific Division	Specific Division	25
External motorised bypass/isolating valves for chiller/boiler	23	23	23	23	23	23	26	26	26	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	25
Specific Division refers to the Division that provided the device. Power drops to be within 1 m (3 ft.) of the device.															

Work Item	Construction	Management				Power Wiring	2			Communication V	Wiring		Software and	Programming	5
<u>Responsibility Matrix</u>: Networked or Local Area Network (LAN) BACnet Interface Device Option. See Section 25 00 13 for definitions.	Submit documentation for approval	Participate/ Provide Assistance	Furnish (or provide device)	Install	Commission	Safety and Interlock wiring	From the Panelboard to the Power Drop	From the Power Drop to the Device	From the Supplier's Equipment	From the BACnet Device to the local Equipment	From the BAS to the BACnet Device	BAS Network Connection	BACnet Interface Device	Supplier's Equipment	Supervisory Control
Native BACnet device (all data link/network layer options) required to make the supplier's equipment operational and networkable to the BACnet Internetwork.	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	26	26	26	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	Specific Division	Specific Division	25
BACnet Interface Device required to convert proprietary protocols and to map proprietary data points/ register values resident in the supplier's equipment control panel to BACnet AV, BV or other Object Types so the BACnet Interface Device will make the supplier's equipment operational and will present to the BACnet Internetwork as a Native BACnet device.	Specific Division	Specific Division	Specific Division		Specific Division	Specific Division	26	26	26	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	Specific Division	Specific Division	25
Any proprietary (non-BACnet) software, computer, printer, cables, USB keys or any other devices required to make the supplier's equipment operational.	Specific Division	Specific Division	Specific Division	-	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division
Provide programming or configuration of the supplier's control panel and/or BACnet Interface Device to meet the Sequence of Operations.	Specific Division	Specific Division		Specific Division	Specific Division	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Specific Division	Specific Division	Specific Division
Provide control, graphics, trends, alarms, schedules for this BACnet Interface Device on the BACnet Internetwork.	25	25	25	25	25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	25	25	25
Network connection to the BACnet Internetwork.	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/I P and 25 for BACnet MS/TP		27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	Specific Division	Specific Division	Specific Division
Any equipment shipped loose or required to be supplied by others to make the supplier's equipment operational.	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	26	26	26	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division
Equipment control panel(s) integral to supplier's equipment. Integral means that the panel is supplied and installed with the equipment and is powered from a single point of connection. Note that this includes equipment provided by the supplier but may be an OEM panel. Note that this does not include the BACnet Interface Device.	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	26	26	26	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division
Equipment control panels NOT integral to supplier's equipment. Note that this includes equipment provided by the supplier but may be an OEM panel. Note that this does not include the BACnet Interface Device.	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	26	26	26	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division
Control panel and BAS device housings and enclosures (Including backboards attached to walls or free standing uni-strut structures).	Specific Division	Specific Division	Specific Division	Specific Division	-	Specific Division	26	26	26	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division

Networked or Local Area Network (LAN) BACnet Interface Device Option. See Section 25 00 13 for definitions. view of the section of the sectio	Work Item	Construction 2	Management				Power Wiring				Communication V	Wiring		Software and	Programming	
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	Responsibility Matrix: Networked or Local Area Network (LAN) BACnet Interface Device Option. See Section 25 00 13 for definitions.	documentation for approv	rticipate/ Provide Assist	(or provide	Install	Commission	and Interlock	e Panelboard to the Power D	the Power Drop to the	Supplier's	the BACnet Device to Equipment		Network	BACnet Interface Device	Equipme	
And water (a), damped (a), sensor((a), transducer((a) or any other level((a)), consultation ((b), consul	Any power wiring for any external valve(s), damper(s), sensor(s), meter(s), transducer(s) or any other device(s)	26	26	26	26	26	26	26	25	26	N/A	N/A	N/A	N/A	N/A	N/A
Any value(15), stans(15), meter(15), trans(16); or any other device(15) or quint (15), stans(15), meter(15), stans(15), equipment, with or subplex(15) control panel equipment, with or subplex(15) control panel equipment, with or subplex(15), stans(15), meter(15), stans(15), meter(15), stans(15), st	Any valve(s), damper(s), sensor(s), meter(s), transducer(s) or any other device(s) required to make the supplier's equipment operational. This includes devices that are called up in the Contract Documents as <u>being</u> external to the supplier's equipment.	25	25	25	25	Specific	26	26	25	26	BACnet/IP and 25 for BACnet	BACnet/IP and 25 for BACnet	BACnet/IP and 25 for BACnet			25
Any wing between ary valve(s), sensor(s), meter(s), transduce(s) or any other device(s) to he supplier's control panel and control	Any valve(s), damper(s), sensor(s), meter(s), transducer(s) or any other device(s) required to make the supplier's equipment operational. This includes devices that are called up as being <u>supplied with the supplier's equipment with or shipped loose</u> equipment in the Contract Documents.	-	<u>^</u>	<u> </u>		Specific	26	26	25	26	BACnet/IP and 25 for BACnet	BACnet/IP and 25 for BACnet	BACnet/IP and 25 for BACnet	-	-	25
control panel and/or equipment.Division	Any wiring between any valve(s), damper(s), sensor(s), meter(s), transducer(s) or any other device(s) to the supplier's control panel required to make the supplier's equipment operational.	25	25	25	25	25	25	26	25	26	BACnet/IP and 25 for BACnet	BACnet/IP and 25 for BACnet	BACnet/IP and 25 for BACnet	-	-	25
connection for controlling the supplier's equipment 25 25 25 25 100	Any wiring between the BACnet Interface Device and the supplier's control panel and/or equipment.	-	-	-	-	-		26	25	26	-	-	-	-	*	25
Starters/HOAs26 <td>Line or low voltage wiring from the BAS panel to the starter or point of connection for controlling the supplier's equipment</td> <td>25</td> <td>25</td> <td>25</td> <td>25</td> <td>25</td> <td>25</td> <td>26</td> <td>25</td> <td>25</td> <td>N/A</td> <td>N/A</td> <td>N/A</td> <td>25</td> <td>25</td> <td>25</td>	Line or low voltage wiring from the BAS panel to the starter or point of connection for controlling the supplier's equipment	25	25	25	25	25	25	26	25	25	N/A	N/A	N/A	25	25	25
Line of sight disconnect switches 26 27 for 82 for 82 for 82 for <td>Breakers in panelboards required for BAS devices of all types</td> <td>26</td> <td>26</td> <td>26</td> <td>26</td> <td>26</td> <td>26</td> <td>26</td> <td>26</td> <td>26</td> <td>N/A</td> <td>N/A</td> <td>N/A</td> <td>26</td> <td>26</td> <td>26</td>	Breakers in panelboards required for BAS devices of all types	26	26	26	26	26	26	26	26	26	N/A	N/A	N/A	26	26	26
Line to low voltage transformers2525252525252626262626N/AN/AN/AN/A262626Duct Smoke Detectors26 <td< td=""><td>Starters/HOAs</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></td<>	Starters/HOAs															
Duct Smoke Detectors 26 26 26 26 26 26 26 26 26 N/A N/A N/A N/A 26 26 26 Safety/high limit wiring 25 25 25 25 25 26 26 26 26 N/A																
Safety/high limit wiring252525252526262626N/AN/AN/A262626LAN connection between the BACnet Interface Device and other BACnet devices that are considered subpanels. The LAN connection may use any BACnet or any proprietary protocol.Specific DivisionSpecific DivisionSpecific DivisionSpecific DivisionSpecific DivisionSpecific DivisionSpecific DivisionSpecific DivisionSpecific DivisionSpecific DivisionSpecific DivisionSpecific DivisionSpecific Division2626N/AN/AN/AN/A262626LAN connection between the BACnet Interface Device and other BACnet BACnet Interface Device and other BACnet BACnet Interface Device and other BACnet BACnet Interface Device and other BACnet DivisionSpecific DivisionSpecific DivisionSpecific DivisionSpecific Division27 for BACnet/IP and 25 for BACnet MS/TP27 for BACnet/IP and 25 for BACnet MS/TP27 for 																
LAN connection between the BACnet Interface Device and other BACnet devices that are considered subpanels. The LAN connection may use any BACnet or any proprietary protocol. Specific Division 1 are																
	LAN connection between the BACnet Interface Device and other BACnet devices that are considered subpanels. The LAN connection may use any BACnet or any proprietary protocol.	Specific	Specific	Specific	Specific	Specific	27 for BACnet/IP and 25 for BACnet				27 for BACnet/IP and 25 for BACnet	27 for BACnet/IP and 25 for BACnet	27 for BACnet/IP and 25 for BACnet	Specific	Specific	
	Specific Division refers to the Division that provided the device															
	Power drops to be within 1 m (3 ft.) of the device.															

Work Item	Construction Ma	nagement				Power Wirin	ıg			Communication Win	ring		Software and I	Programming	
<u>Responsibility Matrix</u>: Single On-Board BACnet Interface Device Option. See Section 25 00 13 for definitions.	Submit documentation for approval	Participate/ Provide Assistance	Furnish (or provide device)	Install	Commission	Safety and Interlock wiring	From the Panelboard to the Power Drop	From the Power Drop to the Device	From the Supplier's Equipment	From the BACnet Device to the local Equipment	From the BAS to the BACnet Device	BAS Network Connection	BACnet Interface Device	Supplier's Equipment	Supervisory Control
Native BACnet device (all data link/network layer options) required to make the supplier's equipment operational and networkable to the BACnet Internetwork.	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	26	26	26	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	Specific Division	Specific Division	25
BACnet Interface Device required to convert proprietary protocols and to map proprietary data points/ register values resident in the supplier's equipment control panel to BACnet AV, BV or other Object Types so the BACnet Interface Device will make the supplier's equipment operational and will present to the BACnet Internetwork as a Native BACnet device.	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	26	26	26	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	Specific Division	Specific Division	25
Any proprietary (non-BACnet) software, computer, printer, cables, USB keys or any other devices required to make the supplier's equipment operational.	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division
Provide programming or configuration of the supplier's control panel and/or BACnet Interface Device to meet the Sequence of Operations.	Specific Division	Specific Division		Specific Division	Specific Division	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Specific Division	Specific Division	Specific Division
Provide control, graphics, trends, alarms, schedules for this BACnet Interface Device on the BACnet Internetwork.	25	25	25	25	25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	25	25	25
Network connection to the BACnet Internetwork.	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/I P and 25 for BACnet MS/TP		27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	Specific Division	Specific Division	Specific Division
Any equipment shipped loose or required to be supplied by others to make the supplier's equipment operational.	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	26	26	26	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division
Equipment control panel(s) integral to supplier's equipment. Integral means that the panel is supplied and installed with the equipment and is powered from a single point of connection. Note that this includes equipment provided by the supplier but may be an OEM panel. Note that this does not include the BACnet Interface Device.	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	26	26	26	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division
Equipment control panels NOT integral to supplier's equipment. Note that this includes equipment provided by the supplier but may be an OEM panel. Note that this does not include the BACnet Interface Device.	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	26	26	26	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division
Control panel and BAS device housings and enclosures (Including backboards attached to walls or free standing uni-strut structures).	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division		26	26	26	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division
Any power wiring for any external valve(s), damper(s), sensor(s), meter(s), transducer(s) or any other device(s)	26	26	26	26	26	26	26	25	26	N/A	N/A	N/A	N/A	N/A	N/A

Work Item	Construction Ma	inagement				Power Wirin	ng			Communication Wir	ing		Software and I	Programming	
Responsibility Matrix: Single On-Board BACnet Interface Device Option. See Section 25 00 13 for definitions.	Submit documentation for approval	Participate/ Provide Assistance	Furnish (or provide device)	Install	Commission	Safety and Interlock wiring	From the Panelboard to the Power Drop	From the Power Drop to the Device	From the Supplier's Equipment	From the BACnet Device to the local Equipment	From the BAS to the BACnet Device	BAS Network Connection	BACnet Interface Device	Supplier's Equipment	Supervisory Control
Any valve(s), damper(s), sensor(s), meter(s), transducer(s) or any other device(s) required to make the supplier's equipment operational. This includes devices that are called up in the Contract Documents as <u>being</u> external to the supplier's equipment.	25	25	25	25	25 and Specific Division	26	26	25	26	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	Specific Division	Specific Division	25
Any valve(s), damper(s), sensor(s), meter(s), transducer(s) or any other device(s) required to make the supplier's equipment operational. This includes devices that are called up as being <u>supplied with the supplier's equipment with or shipped loose</u> equipment in the Contract Documents.	all	all	Specific Division	Specific Division	25 and Specific Division	26	26	25	26	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	Specific Division	Specific Division	25
Any wiring between any valve(s), damper(s), sensor(s), meter(s), transducer(s) or any other device(s) to the supplier's control panel required to make the supplier's equipment operational.	25	25	25	25	25	25	26	25	26	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	27 for BACnet/IP and 25 for BACnet MS/TP	Specific Division	Specific Division	25
Any wiring between the BACnet Interface Device and the supplier's control panel and/or equipment.	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division		26	25	26	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	25
Specific Division refers to the Division that provided the device. Power drops to be within 1 m (3 ft.) of the device.															

Work Item	Construction Ma	nagement					Power Wiring			Communication Wi	ring		Software and	Programming	
Responsibility Matrix: Equipment fitted with Stick Built controls. See Section 25 00 13 for definitions.	Submit documentation for approval	Participate/ Provide Assistance	Furnish (or provide device)	Install	Commission	Safety and Interlock wiring	From the Panelboard to the Power Drop	From the Power Drop to the Device	From the Supplier's Equipment	From the BACnet Device to the local Equipment	From the BAS to the BACnet Device	BAS Network Connection	BACnet Interface Device	Supplier's Equipment	Supervisory Control
<u>Responsibility Matrix</u>: Devices shown on Plans and Specifications in the Division that specifies the supplier's equipment: This category does not include networkable devices. It only includes stick built devices listed in the 25 09 nn.nn sections of the Division 25 Specification or points shown in the Consultant's Contract Documents.															
Temperature sensors	25	25	25	25	25	26	26	26	26	25	25	25	25	25	25
Relative Humidity Sensors	25	25	25	25	25	26	26	26	26	25	25	25	25	25	25
Outdoor air static air sensor probe and pneumatic tubing only.	25	25	25	GC	GC and 25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	25
Piping, guy wires and roof penetrations required for the outdoor air static air sensor probe.	GC	GC	GC	GC	GC and 25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	25
Air flow stations (in duct)	25	25	25	25	25 and TAB	26	26	26	26	25	25	25	25	25	25
Air flow stations (Annubar)	25	25	25	25	25 and TAB	26	26	26	26	25	25	25	25	25	25
Pressure sensors	25	25	25	25	25 and TAB	26	26	26	26	25	25	25	25	25	25
Gas Sensors	25	25	25	25	25	26	26	26	26	25	25	25	25	25	25
Liquid Level Sensors	25	25	25	25	25	26	26	26	26	25	25	25	25	25	25
Liquid Flow Sensors	25	25	25	25	25	26	26	26	26	25	25	25	25	25	25
PIL Switches	25	25	25	25	25	26	26	26	26	25	25	25	25	25	25
Low Limit Switches	25	25	25	25	25	26	26	26	26	25	25	25	25	25	25
Thermostats	25	25	25	25	25	26	26	26	26	25	25	25	25	25	25
Aquastats	25	25	25	25	25	26	26	26	26	25	25	25	25	25	25
Air flow safeties for DX or other applications	25	25	25	25	25	26	26	26	26	25	25	25	25	25	25
Liquid flow safeties	25	25	25	25	25	26	26	26	26	25	25	25	25	25	25
Filter alarm devices - Constant and Variable flow fans	25	25	25	25	25	26	26	26	26	25	25	25	25	25	25
Control Dampers not integral to supplied equipment	25	25	25	25	25	26	26	26	26	25	25	25	25	25	25
Control Damper Actuators not integral to supplied equipment	25	25	25	25	25	26	26	26	26	25	25	25	25	25	25
Control Dampers integral to supplied equipment	Specific Division	Specific Division	Specific Division	Specific Division	Division	26	26	26	26	25	25	25	25	25	25
Control Damper Actuators integral to supplied equipment	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	26	26	26	26	25	25	25	25	25	25
Control Valves not integral to supplied equipment	25	25	25	25	25	26	26	26	26	25	25	25	25	25	25
Control Valve Actuators not integral to supplied equipment	25	25	25	25	25	26	26	26	26	25	25	25	25	25	25
Control Valves integral to supplied equipment	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	26	26	26	26	25	25	25	25	25	25
Control Valve Actuators integral to supplied equipment	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	26	26	26	26	25	25	25	25	25	25
Manual Valves not requiring power.	23	23	23	23	23	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Work Item	Construction Ma	nagement					Power Wiring			Communication Wir	ing		Software and	Programming	
<u>Responsibility Matrix</u>: Equipment fitted with Stick Built controls. See Section 25 00 13 for definitions.	Submit documentation for approval	Participate/ Provide Assistance	Furnish (or provide device)	Install	Commission	Safety and Interlock wiring	From the Panelboard to the Power Drop	From the Power Drop to the Device	From the Supplier's Equipment	From the BACnet Device to the local Equipment	From the BAS to the BACnet Device	BAS Network Connection	BACnet Interface Device	Supplier's Equipment	Supervisory Control
External motorised bypass/isolating valves for chiller/boiler	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	26	26	26	26	25	25	25	25	25	25
Motorized Fire/Smoke Dampers	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	26	26	26	26	26	26	26	26	26	26
Motorized Fire/Smoke Dampers Actuators	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	26	26	26	26	26	26	26	26	26	26
Occupancy, vacancy and daylight sensors used to integrate with HVAC devices. These devices are part of the networked lighting control system.	26	26	26	26	26	26	26	26	26	26	26	27	26	26	25
VAV box controllers supplied to VAV box factory (Devices are BACnet MS/TP).	25	25	25	Specific Division	25	26	26	26 spots power for n devices. 25 runs 24 V power to n devices.	26 spots power for n devices. 25 runs 24 V power to n devices.	25	25	25	25	25	25
VAV box controllers site installed (Devices are BACnet MS/TP).	25	25	25	25	25	26	26	26 spots power for n devices. 25 runs 24 V power to n devices.	26 spots power for n devices. 25 runs 24 V power to n devices.	25	25	25	25	25	25
Variable speed drive integral to supplied equipment	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	26	26	26	26	25	25	25	25	25	25
Variable speed drive separate to supplied equipment	23 or 26	23 or 26	23 or 26	23 or 26	23 or 26	26	26	26	26	25	25	25	25	25	25
Air Compressor - Controls	25	25	25	25	25	26	26	26	26	25	25	25	25	25	25
Air Compressor - Process (not for Controls)	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	26	26	26	26	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	25
Thermowells required for sensors	25	25	25	23	25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Current Switches	25	25	25	25	25	26	26	26	26	25	25	25	25	25	25
Control Relays	25	25	25	25	25	26	26	26	26	25	25	25	25	25	25
Damper endswitches	25	25	25	25	25	26	26	26	26	25	25	25	25	25	25
Steam meters	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	26	26	26	26	25	25	25	25	25	25
Hydronic meters	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	26	26	26	26	25	25	25	25	25	25
Water meters not used by utility for metering.	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	26	26	26	26	25	25	25	25	25	25
Natural gas meter	Owner	Owner and 25	Owner	Owner	Owner	Owner	26	26	26	25	25	25	25	25	25
Electrical Meters not used by utility for billing.	26	26	26	26	26	26	26	26	26	26	26	27	26	26	25
Other	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	26	26	26	26	25	25	25	25	25	25

Work Item	Construction Ma	nagement					Power Wiring			Communication Wi	iring		Software and	Programming	
Responsibility Matrix: Equipment fitted with Stick Built controls. See Section 25 00 13 for definitions.	Submit documentation for approval	Participate/ Provide Assistance	Furnish (or provide device)	Install	Commission	Safety and Interlock wiring	From the Panelboard to the Power Drop	From the Power Drop to the Device	From the Supplier's Equipment	From the BACnet Device to the local Equipment	From the BAS to the BACnet Device	BAS Network Connection	BACnet Interface Device	Supplier's Equipment	Supervisory Control
Low Voltage wiring, conduit and installing and auxiliary equipment needed to support the wiring and installation.	25	25	25	25	25	26	26	26	26	25	25	25	25	25	25
Non-BAS terminal unit internal or external controls for equipment															
Fan Coils (field mounted controls only).	25	25	25	26	25, 26	26	26	26	26	25	25	25	25	25	25
Convectors (field mounted controls only).	25	25	25	26	25, 26	26	26	26	26	25	25	25	25	25	25
Force Flows (field mounted controls only).	25	25	25	26	25, 26	26	26	26	26	25	25	25	25	25	25
Unit Heaters (field mounted controls only).	25	25	25	26	25, 26	26	26	26	26	25	25	25	25	25	25
Other (field mounted controls only).	25	25	25	26	25, 26	26	26	26	26	25	25	25	25	25	25
BAS terminal unit internal or external controls for equipment for which there is a 25 09 nn.nn section in the specification.	25	25	25	25	25	26	26	26	26	25	25	25	25	25	25
Fan Coils (field mounted controls only).	25	25	25	25	25	26	26	26	26	25	25	25	25	25	25
Convectors (field mounted controls only).	25	25	25	25	25	26	26	26	26	25	25	25	25	25	25
Force Flows (field mounted controls only).	25	25	25	25	25	26	26	26	26	25	25	25	25	25	25
Unit Heaters (field mounted controls only).	25	25	25	25	25	26	26	26	26	25	25	25	25	25	25
Radiant panels (field mounted controls only).	25	25	25	25	25	26	26	26	26	25	25	25	25	25	25
Unit Ventilators (MS/TP network connections only). It is assumed that Unit Ventilators only come with factory mounted controls.	25	25	Specific Division	25	25	26	26	26	26	25	25	25	25	25	25
Other (field mounted controls only).	25	25	Specific Division	25	25	26	26	26	26	25	25	25	25	25	25
The Owner is the Lake County.															
Specific Division refers to the Division that provided the device.															
Power drops to be within 1 m (3 ft.) of the device.															

<u>Responsibility Matrix</u>: Devices shown on Plans and Specifications in the Division that specifies Supplier's equipment. This table does not include the Five BACnet Interface Device Types. See Section 25 00 13 for definitions.	Supply	Install	Power Wiring	Low Voltage Control Wiring	Line Voltage Controls Wiring	Low Voltage Interlock Wiring	Line Voltage Interlock Wiring
Temperature sensors (integral to supplied equipment)	E.S.	E.S.	26	E.S.	E.S.	E.S.	26
Temperature sensors (shipped loose by equipment Supplier)	E.S.	E.S.	26	E.S.	E.S.	E.S.	26
Temperature sensors (provided by another Division). This applies only if there is a reference to another Division in this Table. Division 25 reference means Stick-Built Devices.	25	25	26	25	25	25	26
Relative Humidity sensors (integral to supplied equipment)	E.S.	E.S.	26	E.S.	E.S.	E.S.	26
Relative Humidity sensors (shipped loose by equipment Supplier)	E.S.	E.S.	26	E.S.	E.S.	E.S.	26
Relative Humidity sensor (provided by another Division). This applies only if there is a reference to another Division in this Table. Division 25 reference means Stick-Built Devices.	25	25	26	25	25	25	26
Outdoor air static air sensor probe	25	25	N/A	N/A	N/A	N/A	N/A
Air flow stations (in duct) (shipped loose by equipment Supplier)	E.S.	E.S.	26	E.S.	E.S.	E.S.	26
Air flow stations (in duct) (snipped loose by equipment Supplier) Air flow stations (in duct) (provided by another Division). This applies only if there is a reference to another Division in this Table. Division 25 reference means Stick-Built Devices.	E.S. 25	E.S. 25	26	E.S. 25	E.S. 25	E.S. 25	26
Air now stations (in duct) (provided by another Division). This appres only if there is a reference to another Division in this rable. Division 25 reference means stick-Built Devices. Air flow stations (Annubar) (integral to supplied equipment)	E.S.	E.S.	26	E.S.	E.S.	E.S.	26
Air flow stations (Annubar) (hitegraf to supplied equipment) Air flow stations (Annubar) (shipped loose by equipment Supplier)	E.S.	E.S. E.S.	26	E.S.	E.S. E.S.	E.S. E.S.	26
Air flow stations (Annubar) (Simplet roose by equipment Supplier)	E.S.	E.S.	26	E.S.	E.S.	E.S.	26
	L.5.	L.J.	20	L.5.	L.5.	L.5.	20
Pressure sensors (integral to supplied equipment)	E.S.	E.S.	26	E.S.	E.S.	E.S.	26
Pressure sensors (shipped loose by equipment Supplier)	E.S.	E.S.	26	E.S.	E.S.	E.S.	26
Pressure sensors (provided by another Division). This applies only if there is a reference to another Division in this Table. Division 25 reference means Stick-Built Devices.	25	25	26	25	25	25	26
Gas sensors (integral to supplied equipment)	E.S.	E.S.	26	E.S.	E.S.	E.S.	26
Gas sensors (shipped loose by equipment Supplier)	E.S.	E.S.	26	E.S.	E.S.	E.S.	26
Gas sensors (provided by another Division). This applies only if there is a reference to another Division in this Table. Division 25 reference means Stick-Built Devices.	25	25	26	25	25	25	26
Liquid level sensors (integral to supplied equipment)	E.S.	E.S.	26	E.S.	E.S.	E.S.	26
Liquid level sensors (shipped loose by equipment Supplier)	E.S.	E.S.	26	E.S.	E.S.	E.S.	26
Liquid level sensors (provided by another Division). This applies only if there is a reference to another Division in this Table. Division 25 reference means Stick-Built Devices.	25	25	26	25	25	25	26
Liquid level switches (integral to supplied equipment)	E.S.	E.S.	26	E.S.	E.S.	25	26
Liquid level switches (shipped loose by equipment Supplier)	E.S.	E.S.	26	E.S.	E.S.	25	26
Liquid level switches (provided by another Division). This applies only if there is a reference to another Division in this Table. Division 25 reference means Stick-Built Devices.	25	25	26	25	25	25	26
Liquid flow sensors (integral to supplied equipment)	E.S.	E.S.	26	E.S.	E.S.	E.S.	26
Liquid flow sensors (shipped loose by equipment Supplier)	E.S.	E.S.	26	E.S.	E.S.	E.S.	26
Liquid flow sensors (provided by another Division). This applies only if there is a reference to another Division in this Table. Division 25 reference means Stick-Built Devices.	25	25	26	25	25	25	26
Low limit switches (integral to supplied equipment)	E.S.	E.S.	26	E.S.	E.S.	E.S.	26
Low limit switches (shipped loose by equipment Supplier)	E.S.	E.S.	26	E.S.	E.S.	E.S.	26
Low limit switches (provided by another Division). This applies only if there is a reference to another Division in this Table. Division 25 reference means Stick-Built Devices.	25	25	26	25	25	25	26
Thermostats (integral to supplied equipment)	E.S.	E.S.	26	E.S.	E.S.	E.S.	26

<u>Responsibility Matrix</u>: Devices shown on Plans and Specifications in the Division that specifies Supplier's equipment. This table does not include the Five BACnet Interface Device Types. See Section 25 00 13 for definitions.	Supply	Install	Power Wiring	Low Voltage Control Wiring	Line Voltage Controls Wiring	Low Voltage Interlock Wiring	Line Voltage Interlock Wiring
Thermostats (shipped loose by equipment Supplier)	E.S.	E.S.	26	E.S.	E.S.	E.S.	26
Thermostats (provided by another Division). This applies only if there is a reference to another Division in this Table. Division 25 reference means Stick-Built Devices.	25	25	26	25	25	25	26
Aquastats (integral to supplied equipment)	E.S.	E.S.	26	E.S.	E.S.	E.S.	26
Aquastats (shipped loose by equipment Supplier)	E.S.	E.S.	26	E.S.	E.S.	E.S.	26
Aquastats (provided by another Division). This applies only if there is a reference to another Division in this Table. Division 25 reference means Stick-Built Devices.	25	25	26	25	25	25	26
Air flow switches (integral to supplied equipment)	E.S.	E.S.	26	E.S.	E.S.	E.S.	26
Air flow switches (shipped loose by equipment Supplier)	E.S.	E.S.	26	E.S.	E.S.	E.S.	26
Air flow switches (provided by another Division). This applies only if there is a reference to another Division in this Table. Division 25 reference means Stick-Built Devices.	25	25	26	25	25	25	26
Liquid flow switches (integral to supplied equipment)	E.S.	E.S.	26	E.S.	E.S.	E.S.	26
Liquid flow switches (shipped loose by equipment Supplier)	E.S.	E.S.	26	E.S.	E.S.	E.S.	26
Liquid flow switches (provided by another Division). This applies only if there is a reference to another Division in this Table. Division 25 reference means Stick-Built Devices.	25	25	26	25	25	25	26
Filter switches (integral to supplied equipment)	E.S.	E.S.	26	E.S.	E.S.	E.S.	26
Filter switches (shipped loose by equipment Supplier)	E.S.	E.S.	26	E.S.	E.S.	E.S.	26
Filter switches (provided by another Division). This applies only if there is a reference to another Division in this Table. Division 25 reference means Stick-Built Devices.	25	25	26	25	25	25	26
Filter Diff. Pressure Sensors (integral to supplied equipment)	E.S.	E.S.	26	E.S.	E.S.	25	26
Filter Diff. Pressure Sensors (shipped loose by equipment Supplier)	E.S.	E.S.	26	E.S.	E.S.	25	26
Filter Diff. Pressure Sensors (provided by another Division). This applies only if there is a reference to another Division in this Table. Division 25 reference means Stick-Built Devices.	25	25	26	25	25	25	26
Control Dampers (integral to supplied equipment)	E.S.	E.S.	N/A	E.S.	E.S.	E.S.	26
Control Dampers (shipped loose by equipment Supplier)	E.S.	E.S.	N/A	E.S.	E.S.	E.S.	26
Control Dampers (provided by another Division). This applies only if there is a reference to another Division in this Table. Division 25 reference means Stick-Built Devices.	25	25	N/A	25	25	25	26
Control Damper Actuators (integral to supplied equipment)	E.S.	E.S.	26	E.S.	E.S.	E.S.	26
Control Damper Actuators (shipped loose by equipment Supplier)	E.S.	E.S.	26	E.S.	E.S.	E.S.	26
Control Damper Actuators (provided by another Division). This applies only if there is a reference to another Division in this Table. Division 25 reference means Stick-Built Devices.	25	25	26	25	25	25	26
Control Valves (integral to supplied equipment)	E.S.	E.S.	N/A	E.S.	E.S.	E.S.	26
Control Valves (shipped loose by equipment Supplier)	E.S.	E.S.	N/A	E.S.	E.S.	E.S.	26
Control Valves (provided by another Division). This applies only if there is a reference to another Division in this Table. Division 25 reference means Stick-Built Devices.	25	25	N/A	25	25	25	26
Control Valve Actuators (integral to supplied equipment)	E.S.	E.S.	26	E.S.	E.S.	E.S.	26
Control Valve Actuators (shipped loose by equipment Supplier)	E.S.	E.S.	26	E.S.	E.S.	E.S.	26
Control Valve Actuators (provided by another Division). This applies only if there is a reference to another Division in this Table. Division 25 reference means Stick-Built Devices.	25	25	26	25	25	25	26
Manual Valves (integral to supplied equipment)	Specified Div	Specified Div	N/A	Specified Div	Specified Div	Specified Div	26

<u>Responsibility Matrix</u>: Devices shown on Plans and Specifications in the Division that specifies Supplier's equipment. This table does not include the Five BACnet Interface Device Types. See Section 25 00 13 for definitions.

Specified Specified Manual Valves (shipped loose by equipment Supplier) Div Div Specified Specified Manual Valves (provided by another Division). This applies only if there is a reference to another Division in this Table. Div Div Motorized Fire/Smoke Dampers 23 23 Motorized Fire/Smoke Dampers Actuators 26 26 Occupancy sensors (integral to supplied equipment) 26 26 Occupancy sensors (shipped loose by equipment Supplier) 26 26 Occupancy sensors (provided by another Division). This applies only if there is a reference to another Division in this Table. 26 26 25 25 VAV boxes and other Air Terminal Units Vibration isolation and seismic bracing 23 23 Variable speed drives (integral to supplied equipment) 25 25 Variable speed drives (shipped loose by equipment Supplier) 25 25 25 Variable speed drives (provided by another Division). This applies only if there is a reference to another Division in this Table. 25 25 25 Air Compressors (Controls) Specified Specified Air Compressors (Process) Div Div 25 Thermowells (integral to supplied equipment) 25 Thermowells (shipped loose by equipment Supplier) 25 25 Thermowells (provided by another Division). This applies only if there is a reference to another Division in this Table. 25 25 Current Switches (integral to supplied equipment) 25 25 Current Switches (shipped loose by equipment Supplier) 25 25 Current Switches (provided by another Division). This applies only if there is a reference to another Division in this Table. 25 25 Current transducers (integral to supplied equipment) 25 25 Current transducers (shipped loose by equipment Supplier) 25 25 Current transducers (provided by another Division). This applies only if there is a reference to another Division in this Table. 25 25 Voltage transducers (integral to supplied equipment) 25 25 Voltage transducers (shipped loose by equipment Supplier) 25 25 25 25 Voltage transducers (provided by another Division). This applies only if there is a reference to another Division in this Table.

Power Wiring	Low Voltage Control Wiring	Line Voltage Controls Wiring	Low Voltage Interlock Wiring	Line Voltage Interlock Wiring
N/A	Specified Div	Specified Div	Specified Div	26
N/A	Specified Div	Specified Div	Specified Div	26
N/A	23	23	23	26
26	26	26	26	26
26	26	26	26	26
26	26	26	26	26
26	26	26	26	26
20	20	20	20	20
26	25	25	25	26
N/A	N/A	N/A	N/A	N/A
26	25	25	25	26
26	25	25	25	26
26	25	25	25	26
26	25	25	25	26
26	Specified Div	Specified Div	Specified Div	26
N/A	25	25	25	26
N/A	25	25	25	26
N/A	25	25	25	26
26	25	25	25	26
26	25	25	25	26
26	25	25	25	26
26	25	25	25	26
26	25	25	25	26
26	25	25	25	26
26	25	25	25	26
20	23	23	23	20
26	25	25	25	26
26	25	25	25	26
26	25	25	25	26
20	23	23	23	20

Supply

Install

<u>Responsibility Matrix</u>: Devices shown on Plans and Specifications in the Division that specifies Supplier's equipment. This table does not include the Five BACnet Interface Device Types. See Section 25 00 13 for definitions.	Supply	Install	Power Wiring	Low Voltage Control Wiring	Line Voltage Controls Wiring	Low Voltage Interlock Wiring	Line Voltage Interlock Wiring
Control Relays (integral to supplied equipment)	25	25	26	25	25	25	26
Control Relays (shipped loose by equipment Supplier)	25	25	26	25	25	25	26
Control Relays (provided by another Division). This applies only if there is a reference to another Division in this Table.	25	25	26	25	25	25	26
Damper endswitches (integral to supplied equipment)	25	25	26	25	25	25	26
Damper endswitches (shipped loose by equipment Supplier)	25	25	26	25	25	25	26
Damper endswitches (provided by another Division). This applies only if there is a reference to another Division in this Table.	25	25	26	25	25	25	26
Steam meters (integral to supplied equipment)	25	25	26	25	25	25	26
Steam meters (shipped loose by equipment Supplier)	25	25	26	25	25	25	26
Steam meters (provided by another Division). This applies only if there is a reference to another Division in this Table.	25	25	26	25	25	25	26
				1			
Hydronic meters (integral to supplied equipment)	25	25	26	25	25	25	26
Hydronic meters (shipped loose by equipment Supplier)	25	25	26	25	25	25	26
Hydronic meters (provided by another Division). This applies only if there is a reference to another Division in this Table.	25	25	26	25	25	25	26
Non-Utility Water meters (integral to supplied equipment)	E.S.	E.S.	26	E.S.	E.S.	E.S.	26
Non-Utility Water meters (shipped loose by equipment Supplier)	E.S.	E.S.	26	E.S.	E.S.	E.S.	26
Non-Utility Water meters (provided by another Division). This applies only if there is a reference to another Division in this Table.	E.S.	E.S.	26	E.S.	E.S.	E.S.	26
Non-Utility Natural gas meters (integral to supplied equipment)	E.S.	E.S.	26	E.S.	E.S.	E.S.	26
Non-Utility Natural gas meters (shipped loose by equipment Supplier)	E.S.	E.S.	26	E.S.	E.S.	E.S.	26
Non-Utility Natural gas meters (provided by another Division). This applies only if there is a reference to another Division in this Table.	E.S.	E.S.	26	E.S.	E.S.	E.S.	26
Non-Utility Electrical Meters (integral to supplied equipment)	E.S.	E.S.	26	E.S.	E.S.	E.S.	26
Non-Utility Electrical Meters (shipped loose by equipment Supplier)	E.S.	E.S.	26	E.S.	E.S.	E.S.	26
Non-Utility Electrical Meters (provided by another Division). This applies only if there is a reference to another Division in this Table.	E.S.	E.S.	26	E.S.	E.S.	E.S.	26
Other (ALL OTHER DEVICES IN THE WORK NOT ELSEWHERE SPECIFIED	E.S.	E.S.	26	E.S.	E.S.	E.S.	26
	E.3.	E.3.	20	E.3.	E.3.	E.3.	20
Non-BAS terminal unit internal or external controls for equipment Fan Coils	22	22	26	25	26	26	26
	23 23	23 23	26 26	25 25	26 26	26 26	26
Convectors Radiation (Wallfin)	23	23	26	25	26	26	26
Force Flows (Cabinet Unit Heaters)	23	23	26	25	26	26	26
Unit Heaters	23	23	26	25	26	26	26
Other (ALL OTHER DEVICES IN THE WORK NOT ELSEWHERE SPECIFIED	E.S.	E.S.	E.S.	E.S.	26	26	26
	D.0.	L.S.	D.5.	L.D.	20	20	20
BAS terminal unit internal or external controls for equipment							
Fan Coils	23	23	26	25	26	26	26

<u>Responsibility Matrix</u> : Devices shown on Plans and Specifications in the Division that specifies Supplier's equipment. This table does not include the Five BACnet Interface Device Types. See Section 25 00 13 for definitions.	Supply	Install	Power Wiring	Low Voltage Control Wiring	Line Voltage Controls Wiring	Low Voltage Interlock Wiring	Line Voltage Interlock Wiring
Convectors	23	23	26	25	26	26	26
Force Flows	23	23	26	25	26	26	26
Unit Heaters	23	23	26	25	26	26	26
Radiant panels	23	23	26	25	26	26	26
Radiant in-slab heating controls	E.S.	E.S.	26	26	26	26	26
Chilled beam cooling controls	E.S.	E.S.	26	26	26	26	26
Unit Ventilators	23	23	26	25	26	26	26
Other (ALL OTHER DEVICES IN THE WORK NOT ELSEWHERE SPECIFIED	E.S.	E.S.	E.S.	E.S.	26	26	26
Power drops to be within 1 m (3 ft.) of the device. This requirement applies to all devices in the Work.							

Work Item	Constructio	on MaN/Age	ment				Power Wirin	ıg		Communica	tion Wiring		Software an	d Programm	ing
<u>Responsibility Matrix</u>: Equipment fitted with Aux Contact controls. See Section 25 00 13 for definitions.	Submit documentation for approval	Participate/ Provide Assistance	Furnish (or provide device)	Install	Commission	Safety and Interlock wiring	From the Panelboard to the Power Drop	From the Power Drop to the Device	From the Supplier's Equipment	From the BACnet Device to the local Equipment	From the BAS to the BACnet Device	BAS Network Connection	BACnet Interface Device	Supplier's Equipment	Supervisory Control
<u>Responsibility Matrix</u> : Devices shown on Plans and Specifications in the Division that specifies the supplier's equipment: This category does not include networkable devices. It only includes stick built devices listed in the 25 25 nn.nn sections of the Division 25 Specification.															
All Factory supplied Auxiliary Contacts supplied with equipment by Equipment Supplier for direct connection by Division 25	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	26	26	26	25	25	N/A	N/A	Specific Division	Specific Division
All Factory supplied Auxiliary Contacts supplied with equipment by Equipment Supplier for direct connection by Equipment Supplier as part of a Built-Up BACnet Interface Device.	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	Specific Division	26	26	26	Specific Division	Specific Division	N/A	Specific Division	Specific Division	Specific Division
The Owner is the Lake County.															
Specific Division refers to the Division that provided the device.															
Power drops to be within 1 m (3 ft.) of the device.															

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1: GENERAL

1.1 SCOPE

- A. This Section covers basic electrical requirements for providing labor, materials, equipment, and services necessary for the proper grounding and bonding of electrical work as shown on the drawings and specified herein.
 - 1. Grounding conductors and connectors.
 - 2. Grounding bus bar.
 - 3. Grounding electrodes.
 - 4. Telecommunications Bonding and Grounding.
- B. Motorola R56 system throughout Designated Critical Operations Area (DCOA) as defined on electrical overall plan.

1.2 SUBMITTALS

4

- A. Shop Drawings shall be submitted for approval for equipment as follows:
 - 1. Grounding bus bars.
 - 2. Ground ring.
 - 3. Grounding plan including components and grounding riser diagrams.
 - Technology bonding busbars:
 - a. Primary Bonding Busbar (PBB).
 - b. Secondary Bonding Busbar (SBB).
 - c. Main Secondary Bonding Busbar (MSBB).
 - *d.* Riser diagram for the Telecommunications Bonding and Grounding system.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For inclusion in emergency, operation, maintenance and warranty data manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Grounding plan including components (test wells, ground rods, ground ring, etc) and wiring diagrams.
 - 2. Riser diagram for the Telecommunications Bonding and Grounding system.
 - 3. Test Data: Results of grounding test results.

1.4 REFERENCES

- A. The products provided by this section shall comply with the following applicable references (latest edition):
 - 1. Motorola R56-2017 Standards and Guidelines for Communication Sites
 - 2. ANSI / ASTM B3 & B8 Annealed Bare Copper Conductor
 - 3. ANSI/TIA-607-D: Generic Bonding and Grounding (Earthing) for Customer Premises
 - 4. BICSI TDMM 14th Edition Chapter 8 Bonding and Grounding (Earthing)

1.5 QUALITY ASSURANCE

- A. 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.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2: PRODUCTS

2.1 GENERAL INFORMATION.

A. All electrical equipment and material shall be new and bear a recognized testing laboratory's label, where applicable. The type of equipment and/or material shall be designated by the location where it will be installed and so defined by NEMA / NFPA 70 standards.

2.2 GROUNDING CONDUCTORS AND CONNECTORS

- A. Conductors:
 - 1. Insulated Conductors: Copper wire insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
 - 2. Bare Copper Conductors: ASTM / UL.
 - 3. Telecommunications Bonding and Grounding conductors:
 - a. Shall be sized according to requirements in ANSI/TIA-607-D.
 - b. Conductors from the Primary Bonding Busbar (PBB) and Secondary Bonding Busbar (SBB) to noncurrent carrying metals shall be minimum of 6 AWG, minimally. They shall be sized according to length as required by Motorola R56 and ANSI/TIA-607 D, the more stringent shall apply.
- B. Connectors:
 - 1. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.
 - 2. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted-pressure-type, with at least two bolts
 - 3. Pipe Connectors: Clamp-type, sized for pipe.
 - 4. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
 - 5. Telecommunications Bonding and Grounding Connectors:
 - a. Terminations at the telecommunications grounding busbar shall be made with dual-hole, dual-crimp lugs with two 300-series stainless-steel hex-head bolts, properly crimped using minimally a 2-ton rated crimping/swaging tool and tightened to meet manufacturer's torque specifications. Phillips-head screws are not acceptable.
 - b. Lugs shall be manufactured of tin plated copper and fastened via irreversible 2-ton, minimal compression (crimped) and shall have spacing to fit an ANSI/TIA-607 standards compliant predrilled busbar.
 - c. Approved Lugs: Panduit LCC or LCCX series or equivalent
 - d. HTAPs shall be contained in clear covers that allow inspection of the die marks to ensure that the proper die was used.
 - e. Approved HTAPs: Panduit HTWC series or equivalent.
 - f. An antioxidant compound, approved for the metals being joined, shall be used on all mechanical connections.
 - g. All mechanical connection hardware shall be 300-series stainless-steel.
 - h. Clamps, lugs, and other mechanical connection devices shall be suitable and compatible for materials being bonded, thus eliminating dissimilar metal contact.

2.3 GROUNDING BUS BAR

A. Grounding Bus Bar: Rectangular bars of tin-plated copper, 1/4 by 4 inches in cross section, unless otherwise indicated; with 2kV rated insulators.

2.4 TELECOMMUNICATIONS BONDING BUSBARS

- A. ANSI/TIA-607 pattern, predrilled copper busbar with holes for use with two-hole lugs. Minimum dimensions of .25 inches thick by 4 inches wide. Length sized appropriately to the application with 150% growth. PBB, and -SBB, and MSBB shall have 2kV, minimal, insulators and mounting brackets.
- B. Must be listed by a Nationally Recognized Testing Laboratory (NRTL).
- C. Approved manufacturer: Panduit GB4B series or equivalent.

2.5 GROUNDING ELECTRODES

A. Grounding Rods:
1. Ground Rods – Copper clad steel, ³/₄" diameter, 10' long.

PART 3: EXECUTION

3.1 GENERAL INFORMATION

- A. Grounding shall be in accordance with NEC Article 250.
- B. Grounding and bonding shall be installed in a neat and workmanlike manner. The NEIS Standard Practices for Good Workmanship in Electrical Contracting NECA 1-2006 is hereby adopted to define such workmanship and the installation of conductors and cables.
- C. Equipment grounding conductors shall be installed in all conduits.

3.2 APPLICATIONS

- A. Equipment Grounding Conductor Application: Comply with NEC Article 250 for types, sizes, and quantities of equipment grounding conductors, except where specific types, larger sizes, or more conductors than required by NEC are indicated.
 - 1. Provide ground wire in all raceways as the equipment ground conductor.
 - 2. Conductors: Install solid conductor for No. 14 AWG and smaller, and stranded conductors for No. 12 AWG and larger, unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare copper conductor, No. 4/0 AWG minimum.
 - 1. Bury at least 30 inches below grade or below the frost line, the greater shall apply.
 - 2. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.
- C. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors, except as otherwise indicated.
 - 3. Connections to Structural Steel: Welded connectors.
- D. Grounding Bus Bar: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated on
 - 1. Install bus on 2kV-insulated spacers 2-inch minimum, from wall, 12-inches above finished floor, unless otherwise indicated.
- E. Grounding at the Service: Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

- F. Separately Derived Systems:
 - 1. Generators Connected with 4-Pole Transfer Switch: Install grounding electrode in the form of ground rod at the generator location to establish separately derived ground at generator. The electrode shall be connected to the equipment grounding conductor and to the frame of the generator.
- G. Bonding of Piping Systems and Exposed Structural Steel: Where required by NEC to be grounded, provide bonding in accordance with NEC paragraph 250.102. (Including bonding to separately derived system.)
- H. Signal and Communications: For telephone, alarm, and communication systems, provide a No. 4 AWG minimum green insulated copper conductor in raceway from the grounding electrode system to each terminal cabinet or central equipment location. The conductor shall be sized per length as required by Motorola R56 and ANSI/TIA-607 D, the more stringent shall apply.
- I. Metal Poles Supporting Outdoor Lighting Fixtures: Provide equipment grounding conductor from panel to pole. Provide ground rod below grade near base of pole. Bond equipment grounding conductor with ground rod, pole ground lug and luminaire ground. If the pole is located within 10-feet of the external ground electrode system it shall bond to the grounding electrode system, per Motorola R56 requirements.

3.3 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Grounding Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.
- C. Pad-Mounted Transformers and Switches: Provide ground rod, and grounded neutral or grounded phase conductor, to ground supply transformer to meter socket and each service disconnection means, or as required by Utility.

3.4 INSTALLATION

- A. General: Ground electrical systems and equipment in accordance with NEC requirements, except where the Drawings or Specifications exceed NEC requirements.
- B. Provide and install grounding electrode systems according to NEC Article 250. Route insulated grounding conductors along the shortest and straightest paths possible without obstructing access or placing conductors where they may be subjected to strain, impact, or damage, except as indicated. Bond the following items together to form the service entrance ground:
 - 1. Main water service piping (and associated supplemental ground rod).
 - a. Metallic Water Service Pipe: Provide insulated copper ground conductors, sized as indicated, in conduit from the building main service equipment, or the ground bus, to main metallic water service entrances to the building. Connect ground conductors to the main metallic water service pipes by means of ground-clamps/connectors. Where a dielectric main water fitting is installed, connect the ground conductor to the street side of the fitting. Do not install a grounding jumper around dielectric fittings. Bond the ground conductor conduit to the conductor at each end.
 - b. Ground Rods: Provide ground rods required to achieve 5 ohms. Locate a minimum of 1.75-two-rod lengths from each other and at least the same distance from any other grounding electrode. Interconnect ground rods with bare conductors buried at least 30 inches below grade or below the frost line, the greater shall apply. Connect bare-cable ground conductors to ground rods by means of exothermic welds except as otherwise indicated. Make these connections without damaging the copper coating or exposing the steel. Use ground rods as noted above except as otherwise indicated. Drive rods until tops are 30 inches below finished floor or final grade or below frost line, the greater shall apply, except as otherwise indicated.
 - 2. Building steel. Connect ground electrode structural steel components that is connected / bonded to earth.

- 3. Concrete encased electrode (Ufer).
 - a. Ufer Ground (Concrete-Encased Grounding Electrode) Footing Steel: Fabricate with 20 feet of conductor laid lengthwise in excavation for foundation or footings. Install so conductor is within 2 inches of the bottom of the concrete. Where base of foundation is less than 20 feet in length, coil excess conductor at base of foundation. Bond conductor to reinforcing steel at four locations, minimum. Extend conductor below grade and connect to building grounding grid or grounding electrode.
- 4. Secondary Bonding Busbar (SBB):
 - a. In Telecommunictions Rooms and Data Centers, locate approximately 24 inches above finished floor.
 - b. Where there is an RF cable entry port locate just beneath the entry port.
 - c. Otherwise mount 96 inches above finished floor, unless specifically indicated otherwise.
- 5. Ground ring:
 - a. Ground-Ring: Install a grounding conductor, electrically connected to ground rods and to each steel column extending as shown on drawings. Install copper conductor not less than No. 4/0 AWG for ground ring and for taps to building steel. Bury ground-ring not less than 24 inches (600 mm) from building foundation.
- 6. Lightning Protection:
 - a. Common Ground Bonding with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

C. Bonding:

1. Bond interior metal piping systems and metal air ducts to equipment ground conductors of pumps, fans, electric heaters, and air cleaners serving individual systems.

3.5 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1. Feeders and branch circuits.
 - 2. Lighting circuits.
 - 3. Receptacle circuits.
 - 4. Single-phase motor and appliance branch circuits.
 - 5. Three-phase motor and appliance branch circuits.
 - 6. Flexible raceway runs.
 - 7. Armored and metal-clad cable runs (where cables are allowed by Section 260519 Low-Voltage Electrical Power Conductors and Cables).
 - 8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
- B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

3.6 CONNECTIONS

- A. General: Make connections in such a manner as to minimize possibility of galvanic action or electrolysis. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
 - 1. Provide electroplated or hot-tin-coated materials to assure high conductivity.
 - 2. Make connections with clean bare metal at points of contact.
 - 3. Make copper to steel connections with tin-plated copper mechanical clamps. Make aluminum to copper connections with bimetallic connectors (i.e. stainless steel).

- 4. Coat and seal connections involving dissimilar metals with inert material such as red lead paint to prevent future penetration of moisture to contact surfaces.
- B. Exothermic Welded Connections: Use for connections to structural steel and for underground connections. Provide at connections to ground rods and plate electrodes. Comply with manufacturer's written recommendations and instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
- C. Terminate insulated equipment grounding conductors for feeders and branch circuits with pressure-type grounding lugs. Where metallic raceways terminate at metallic housings without mechanical and electrical connection to the housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to the ground bus in the housing. Bond electrically noncontinuous conduits at both entrances and exits with grounding bushings and bare grounding conductors.
- D. Tighten screws and bolts for grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torque requirements are not indicated, tighten connections to comply with torque tightening values specified in UL 486A and UL 486B.
- E. Compression-Type Connections: Use hydraulic compression tools to provide the correct circumferential pressure for compression connectors. Use tools and dies recommended by the manufacturer of the connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on the ground conductor.
- F. Moisture Protection: Where insulated ground conductors are connected to ground rods or ground buses, insulate the entire area of the connection and seal against moisture penetration of the insulation and cable.
- G. Equipment Grounding Wire Terminations: For No. 12 AWG and larger, use pressure-type grounding lugs; for No. 14 AWG and smaller grounding conductors, terminate with winged pressure-type connectors.
- H. Telecommunications Grounding and Bonding
 - 1. General Requirements:
 - a. The grounding/earthing system shall be intentional, visually verifiable, and adequately sized to handle expected currents safely, and directs these potentially damaging currents away from sensitive network equipment.
 - b. Building steel and metallic water piping may not be substituted for the telecommunications bonding backbone (TBB).
 - 2. Bonding conductors shall:
 - a. Run without splices between termination points
 - b. Avoid unnecessary loops
 - c. Not have sharp bends
 - d. Not be excessive in length
 - e. Run directly as possible
 - f. Be terminated at each end using UL-listed termination methods
 - g. Have inspection windows allowing for connections to be inspected for full conductor insertion
 - h. Have die index numbers embossed on all compression connections to allow crimp inspection.
 - i. Have solid mechanical compression terminations that are irreversible.
 - j. Have bonding hardware that breaks through paint and powder coatings to make solid, reliable contact with the metal substrate. Paint, grease, etc. shall be removed to a bare surface. Paint breaking hardware shall not be relied upon.
 - k. Have terminations at the grounding busbar made with dual-hole, dual-crimp lugs with two 300-series stainless-steel hex-head bolts, properly crimped using crimping/swaging tool and tightened to meet manufacturer's torque specifications, 2-ton minimum pressure, the greater shall apply. Phillips-head screws are not acceptable.
 - 1. Use antioxidant when making bonding connections in the field. The antioxidant shall be appropriate for the materials being bonded together.

- m. Be no smaller than No. 6 AWG and green in color. Other sizes shall be according to Motorola R56 Table 5-3 and ANSI/TIA 607 D Table 1.
- n. Be labeled to identify the termination point of the opposite end of the conductor. The labels shall be nonmetallic material.
- 3. Grounding and Bonding Conductors shall be appropriately sized according to requirements in ANSI/TIA-607-D: Generic Bonding and Grounding (Earthing) for Customer Premises.
- 4. Telecommunications Grounding Busbar shall be sized to allow for at least 150% additional unused terminal spaces for future use after the project has been completed.
- Provide a #2 AWG #6-2 AWG, minimal, bonding conductor between the grounding busbar in the technical power panel and the Secondary Bonding Busbar (SBB). Other sizes shall be according to Motorola R56 Table 5-3 and ANSI/TIA 607 D Table 1.
- 6. Bond all non-current-carrying metallic components to the Telecommunications Bonding and Grounding system, including, but not limited to, equipment, racks, ladder racks, enclosures, cable trays, etc.
- 7. Individual segments of ladder rack and cable tray must be bonded together, on both sides of the tray, to form an electrically continuous installation. All bonding and grounding components must be approved by the cable support system manufacturer and Motorola R56, the more stringent shall apply.
- 8. Any metallic conduit that carries a grounding conductor and is greater than 3 feet long shall have both ends bonded to the conductor with a bonding jumper no longer than 12 inches, fastened with a compression HTAP to the conductor on one side and to the conduit on the other. The bonding conductor shall be the same size as the largest bonding/grounding conductor within the conduit.
- 9. Refer to drawings for grounding riser.

3.7 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports. Testing to be done in presence of commissioning agent.
 - 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 - 2. Test completed grounding system at service disconnect enclosure grounding terminal. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by the 4- point method in accordance with Section 9.03 of IEEE 81, "Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Grounding System."
- B. Report measured ground resistances that exceed the following values:
 - 1. Per Motorola R56 the site is a type B2 site (dispatch and towers are collocated). Ground resistance shall be 5 ohms, minimally. The system *shall should* be designed and submitted to comply with these requirement.
- C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect/Engineer promptly and include recommendations to reduce ground resistance.

3.8 **DEMONSTRATION**

- A. Demonstrate functionality of grounding system including tasks related to test wells.
- B. Film training of systems as part of closeout documents. Refer to 01 79 00 Demonstration and Training for specific information.

3.9 ADJUSTING AND CLEANING

A. Restore surface features at areas disturbed by excavation and reestablish original grades except as otherwise indicated. Where sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other Work to their original condition. Include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, or mulching. Perform such Work in accordance with Division 2 Section "Landscape Work." Maintain disturbed surfaces. Restore vegetation in accordance with Section "Landscape Work." Restore disturbed paving as indicated.

END OF SECTION 26 05 26

SECTION 26 09 23

LIGHTING CONTROL SYSTEM

PART 1: GENERAL

1.1 SCOPE

- A. This Section includes the furnishing and installing of all labor, materials, tools, appliances, control hardware, sensor, wire, junction boxes, and equipment necessary for and incidental to the delivery, installation, and furnishing of a lighting control system as described herein. Unidentified devices shall be the same types as those provided in similar areas.
- B. Provide wired network devices for interior spaces, and wireless network controls for exterior fixtures.

1.2 SUBMITTALS

4.

- A. Shop Drawings shall be submitted for approval for all lighting control devices as follows:
 - 1. Networked lighting system control and relay panels.
 - 2. System software interfaces.
 - a. Management interface.
 - System backbone and integration equipment.
 a. System controller.
 - Wired networked devices.
 - a. Wall stations.
 - b. Graphic wall stations.
 - c. Auxiliary input/output devices.
 - d. Occupancy sensors.
 - e. Photocell sensors
 - f. Wall switch sensors.
 - g. Plug load control.
 - h. Power packs and secondary packs.
 - i. Relay and dimming panels.
 - j. Communication bridge.
 - 5. Wireless networked devices.
 - a. Wireless networked outdoor occupancy and photosensors.
 - b. Wireless networked indoor embedded sensors.
 - c. Wireless networked luminaires.
 - 6. Line-voltage light switches.
 - 7. Emergency shunt relays.
 - 8. Client Front End and Configuration software requirements for installation on Owner's VM.
 - 9. BACnet Interface Device showing proprietary lighting points to be mapped to BACnet Object Types.
 - 10. Communications protocols used in the Work.
 - 11. AutoCAD Drawing showing as-built locations of all occupancy/vacancy sensors for use by BAS Contractor to comply with CA Title 24 Standby Occupancy requirements.
- B. While "typical" connections and circuits are of interest, complete system Shop Drawings shall be prepared for this particular project that include device layout, orientation, point-to-point wiring diagram(s), and conductor sizes and types.
 - 1. Submit any interconnection diagrams to the lighting control panel showing proper wiring.
 - 2. Submit lighting plan showing location, orientation, and coverage area of each sensor.
- C. Samples of any or all proposed equipment or system components shall be submitted for examination/approval as requested.
- D. Record Drawings. The Contractor shall keep layout plans on the job site, marking all changes made during installation. A set of As-Built / Record drawings shall be submitted.

E. Final Documentation. Submit all operation, maintenance and warranty data manuals showing test results.

1.3 QUALITY ASSURANCE

- A. The equipment manufacturer shall be regularly engaged in manufacture of lighting control devices, of the types and capacities required, and whose products have been in satisfactory use in similar service for not less than ten years.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70 by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. System shall be listed as qualified under DesignLights Consortium Networked Lighting Control System Specification (latest version).
- D. Source Limitations: Obtain lighting control network devices from single source from single manufacturer.

1.4 WARRANTY

- A. The manufacturer shall provide a minimum five-year warranty on all hardware devices supplied and installed. Warranty coverage shall begin on the date of shipment.
- B. The hardware warranty shall cover repair or replacement any defective products within the warranty period.
- C. The manufacturer shall make available to the owner new parts, upgrades, and/or replacements available for a minimum of 5 years following installation.

1.5 RELATED SECTIONS

- A. Division 25 Section 25 20 26.09.23 Integrated Automation BACnet Interface Device (Gateways/Native BACnet Devices) Lighting Control Devices (All Types).
- B. 25 00 13 Integrated Automation General Requirements All Trades Work Responsibilities.
- C. Division 25 Schedule 3 BACNET SINGLE LINE DIAGRAM AND RESPONSIBILITY MATRIX (APPLIES TO ALL TRADES).

PART 2: PRODUCTS

2.1 GENERAL INFORMATION

- A. All electrical equipment and material shall be new and bear a recognized testing laboratory's label, where applicable. The type of equipment and/or material shall be designated by the location where it will be installed and so defined by NEMA / NFPA 70 standards.
- B. Provide complete lighting control system as described herein and on the drawings. Plans are schematic and show intent (switching locations/quantities, sensor locations/quantities, control zones, dimming requirements, manual/automatic requirements, normal/emergency requirements, etc). Ancillary parts such as room controllers, power packs, device managers, cabling, etc are not shown on plans and shall be included in the contractor's bid.
- C. Products: Subject to compliance with requirements, provide one of the following manufacturers:
 - 1. Cooper Fifth.
 - 2. Hubbell Lighting.
 - 3. Lithonia Lighting; Acuity Lighting Group, Inc.
 - 4. Watt Stopper (The).

2.2 LIGHTING CONTROL SYSTEM REQUIREMENTS FOR NETWORKED AND RELAY LIGHTING SYSTEMS

- A. Lighting Controls: Ten-year operational life while operating continually at any temperature in an ambient temperature range of -25 C (-13 F) to 40 C (104 F) and 90 percent non-condensing relative humidity.
- B. Designed and tested to withstand discharges without impairment of performance when subjected to discharges of 15,000 volts per IEC 801-2.
- C. Lighting control system (both networked and relay lighting components) shall be designed to allow control of lighting and associated systems via switches, preset/fader, BACnet Interface Device(s), occupancy/vacancy sensors, contactors, plug load controllers, daylight sensors, and astronomical/time-of-day scheduling controls.
- D. Dimming system presets shall be programmable via preset/fader station directly at the control panel, or via networkbased workstation software.
 - 1. Dimming presets shall have discrete fade times with 0.1 second resolution, programmable from zero to 24 hours, and shall be selectable via button, fader, clock event, macro or network interface.
- E. Clock events shall be activated by calendar schedule, by day type and/or specific day programming, including every day, weekday, weekend, S, M, T, W, T, F, S and Holiday.
 - 1. Clock events shall also be activated by astronomical events, which will compensate for daylight savings time and will have programmable setback periods relative to sunrise and sunset.
- F. The lighting control system shall be capable of implementing On commands, Off commands, Raise (dimming) commands, Lower (dimming) commands for any relay, group or zone by means of digital wall switches, photocell or occupancy/vacancy sensor.
 - 1. Web-based software or other devices such as smartphones not approved by Owner's IT department are not allowed be used to control any lighting devices.
 - 2. Owner's IT department may permit limited control of lighting devices from an occupant's managed environment PC or laptop only.
- G. Channels for grouping relays shall be provided, each with an associated pushbutton to toggle the channel ON/OFF and a terminal block for a separate dry contact input.
 - 1. Any number of relays in the panel can be assigned to each channel, with overlapping allowed.
 - 2. Channels shall be set up via communication line communications and networking. Each channel pushbutton shall provide LED status indication.
 - 3. The panel shall also have the ability to assign functions to relays independently of the channels.
 - 4. Panels shall be addressable with DIP switches or other local means to set panel address.
- H. Lighting control system shall accept any type of switch input, including momentary or maintained.
- I. Lighting control system shall support by relay or zone the "blink warning" function.
 - 1. Lighting control system shall flash lights Off/On prior to the lights being turned Off.
 - 2. The warning interval time between the flash and the final lights off signal shall be definable for each zone.
 - 3. Occupant shall be able to override any scheduled Off sweep using local wall switches within the occupied space.
 - 4. Occupant override time shall be locally and remotely programmable and shall not exceed two (2) hours.
- J. System shall provide temporary override conditions for each relay or dimmer so that lights can always be turned on.
- K. All programming and scheduling shall be able to be done locally at the master lighting control panel and remotely (where authorized) via Owner's Enterprise LAN.
 - 1. Remote connection to the lighting control system shall provide real-time control and real-time feedback.
 - 2. Lighting control system shall be able to be monitored by and take commands from the client Front End and configuration software.
 - 3. Lighting control system shall operate without need for a connection to the client Front End.

- L. All programs, schedules, time of day, etc., shall be held in non-volatile memory for a minimum of two (2) years at power failure.
 - 1. At restoration of power, lighting control system shall implement programs required by current time and date.

2.3 LIGHTING CONTROL PANELS FOR NETWORKED AND RELAY LIGHTING SYSTEMS

- A. Provide Lighting Control Panel(s) in a pre-assembled NEMA 1 (indoors) or NEMA 4 (outdoors) enclosure with terminal blocks listed for field wiring at locations shown on the Drawings.
- B. Integrate control station devices, power panels, preset lighting controls, and external inputs into single customizable, multiple failsafe lighting control system, operable manually, automatically or through computer control.
- C. Provide astronomical time clock in networked control lighting panel and in each outdoor lighting fixture.
- D. All Lighting Control Panels shall maintain a backup of the programming in a non-volatile memory capable of lasting more than tenwo years without power.
 - 1. Cabinets and Enclosures: NEMA 1 (indoors) or NEMA 4 (outdoors) enclosure sized to accept required relays and dimmers. Surface-mounted cover as required, with captive screws in a hinged, lockable configuration.
 - 2. Interior: Interiors shall be provided with installed and tested relays or dimming and interface modules.
 - 3. Power Supply: Transformer assembly including internal overcurrent protection with automatic reset and metal oxide varistor or other protection arrangements, against power line spikes.
 - 4. Panel shall be provided with expansion space for ease of installation of other system components (e.g., timeclock and/or photocell controller).
 - 5. Terminals shall be included in the interior to accept a communication line for the connection of communication line switches to the system, or to allow a communication line to be run between multiple panels for network communications.
 - All communications protocols used by the Lighting Control Panels shall be approved via the Submittal process.
 a. Lighting Control Panel networks that rely on Multicasting for panel to panel or panel to device communications are not allowed in the Work.
- E. Accessory Enclosure:
 - 1. Provide an accessory enclosure with mounting area and connections for communication line and optional power supply as needed for remote mounting of interface modules. Interface modules, including clocks, BACnet Interface Device low voltage controls, etc., shall have their communication line cables connected to a terminal board in the accessory enclosure.
 - 2. Additional power may be supplied, if needed, by installing a transformer power supply in the space provided in the enclosure.
- F. Switch Interface: Control panels shall be designed to provide eight (8) dry maintained or momentary contact input or output signals for interface to fire alarm, security, building controls and other associated systems.
- G. System shall include an Ethernet port for connection to Owner's Enterprise LAN, permitting remote management of system from local or wide area network connection.

2.4 LIGHTING CONTROL CLIENT FRONT END AND CONFIGURATION SOFTWARE

- A. Provide Lighting Control Client Front End and Configuration software that is designed, tested, manufactured, and warranted by a single lighting system manufacturer.
 - 1. Install software on a VM spun up by Owner. Local PCs are not allowed in the Work.
 - 2. Provide VM requirements (Microsoft server 2019, .NET, SQL server, 365 Office Suite, etc.) as Submittal for review and approval. License shall support a minimum of 5 seats.
- B. All Client front end and configuration software requirements listed in this Specification Section shall apply to both the networked lighting and relay lighting systems specified in the Work.
- C. Client software configuration requirements
 - 1. Programming and configuration of all devices provided in the Work.

- 2. Device addressing.
- 3. Device grouping. Support of the BACnet service WriteGroup is not required.
- 4. Scheduling.
- 5. Occupancy/vacancy sensor timeouts.
- 6. Daylight sensor configuration.
- 7. Lighting scene configuration.
- 8. Configuration of the buttons and other features in the local room controllers.
- 9. Software shall permit writeable zone and device and point naming.
- 10. Software shall include astronomical timeclock, scheduling, holiday override and override functions.
- 11. System shall support the lighting sequence. Engineer will assign sequences to specific devices that the Lighting System Contractor shall implement. Typical sequences include the following:
 - a. Lights turned ON with the switch and turned OFF with switch. Occupancy sensor will turn OFF upon vacancy change of state.
 - b. Lights turned ON with the occupancy sensor. Can be turned OFF/ON with switch. Occupancy sensor will turn OFF upon vacancy.
 - c. Occupancy sensor turns lights ON/OFF.
 - d. Switch ON/OFF only.
 - e. Time triggers a Blink Warn sequence, an OFF blink followed by a variable ON delay. Switch interrupts sequence and starts override timer. Will automatically turn OFF if override timer reaches zero.
 - f. Turn ON at specific time as defined by the assigned schedule.
 - g. Turn OFF at specific time as defined by the assigned schedule.
 - h. Occupancy sensor turns ON lights with occupancy. Measured light levels above daylight sensor trigger point turns OFF or keep lights OFF. Below set-point allows control by Occupancy Sensor. Occupancy Sensor turns OFF lights with vacancy.
 - i. Switch turns ON/OFF lights. Measured light levels above photocell trigger point turns OFF or keep lights OFF, below set-point. This allows control by occupancy sensor. Occupancy sensor turns OFF lights with vacancy.
 - j. Occupancy sensor turns ON lights with occupancy. Measured light levels above daylight sensor trigger point turns OFF or keep lights OFF, below set-point allows occupancy sensor control. Switch can turn ON/OFF lights by over-riding occupancy sensor control. Occupancy sensor will turn OFF lights upon vacancy.
 - k. Switch ON/OFF. Measured light levels above daylight sensor trigger point turns OFF or keep lights OFF, below set-point allows switch control.
 - 1. Turn ON at specific time (Used for exterior lighting). Measured light levels above fixture photocell trigger point turns OFF or keep lights OFF. Below set-point relinquishes control to the constant ON state.
- D. Front End Graphics requirements
 - 1. Provide graphic user interface of a visual representation of a specific area or zone indicating status of load(s).
 - 2. Provide the following graphics.
 - a. Floor plan graphics showing the state of all lighting and plug load controller devices in the Work.
 - b. Equipment graphics that show a one-line riser diagram of all lighting and plug load devices in the Work both BACnet based and proprietary devices.
 - c. Provide hyperlinks to each device to permit a right mouse click to get to the device property configuration page.
 - d. Graphics shall support change of state or change of value by a color and blink or other animation as required by Owner.
 - e. Front End graphics that do not support color changes or animation are not allowed in the Work.
 - f. Provide samples of graphics for approval via the Submittal process.
- E. Lighting Controls Contractor BACnet Interface Device Creation Requirements
 - 1. Each LED driver, occupancy, daylighting or other lighting device provided by Lighting Controls Contractor shall be represented as a virtual BACnet device for access via the Contractor's BACnet Interface Device.
 - 2. When mapping these lighting devices to BACnet, Lighting Controls Contractor shall not group nor combine multiple occupancy sensors nor LED drivers together to represent more than one device. If the Drawings show more than one fixture/luminaire controlled by a driver then this is considered to be a single device that cannot be subdivided to the individual fixture/luminaire.

- 3. Every power and energy consuming device shall have non-revenue grade kW and kWh information exposed as a BACnet object property or similar mapping arrangement. Aggregation of power and energy data from multiple devices in to one object property is not allowed. Aggregation will be done by others.
- 4. Contractor shall submit a BACnet device object list as Shop Drawing Submittal based on the requirements outlined in this Section.
- 5. No Work to create BACnet objects shall be done until this Submittal is approved.
- 6. The BACnet Interface Device shall support AV, BV and MSV BACnet Object Types. The Lighting System BACnet Interface Device shall at minimum support the B-ASC BACnet Device Profile per SSPC 135-2020.
- 7. Support for the lighting device BACnet Profiles, the Lighting Output Object Type and services such as WriteGroup are optional.
- 8. Support for BACnet trending, alarming and scheduling is not required. Software shall at minimum support a proprietary scheduling mechanism that can be applied to devices or groups of devices.
- 9. BACnet Device and Object names shall support a minimum of 32 characters. All Device and Object Names and descriptions, Instance Numbers and Network Numbers shall be writeable and shall be set by Owner for configuration by Lighting Control System Contractor.
- 10. Provide BACnet Interface Devices for each lighting device (LED drivers, relay controls, occupancy/vacancy sensors, daylight sensors, and other devices) so that the units are presented as a series of AV, BV and MSV BACnet objects. See 25 20 26.09.23 for the list of objects that must be supported. This list is the minimum acceptable.
- F. Work to comply with CA Title 24 Standby Occupancy Requirements
 - 1. Contractor shall update the Owner's copy of the building AutoCAD floor plan Drawing to show the as-built location of all lighting occupancy/vacancy sensors provided in the Work. Turn over to BAS Contractor via the Submittal process.
 - 2. BAS Contractor shall use the occupancy/vacancy sensors on this Drawing to set back or set up (depending on the season) the VAV box space temperature when the room is considered to be unoccupied per CA Title 24 30 minute timeout. This Contractor is responsible for ensuring that the occupancy/vacancy sensors are communicating via BACnet. This Contractor has no responsibility for commissioning any of the BAS Contractor's CA Title 24 Work. BAS Contractor shall use the occupancy/vacancy sensors on this Drawing to set back or set up (depending on the season) the VAV box space temperature when the room is considered to be unoccupied per CA Title 24 30 minute timeout. This Contractor is only responsible for ensuring that the occupancy/vacancy sensors communicating via BACnet. This Contractor has no responsibility for commissioning any of the BAS Contractor's CA Title 24 Work.

2.5 WIRELESS NETWORKED CONTROLS (EXTERIOR FIXTURES ONLY)

- A. No wired connections between networked devices shall be required for the purposes of system communications.
- B. Multiple wireless networking protocols shall be supported:
 - 1. A standards based, distributed star topology type of protocol for 900 MHz communication, so as to support lighting control applications and IoT applications.
 - 2. A Bluetooth standard protocol for 2.4 GHz communication that supports direct connection to a smartphone and tablet device, so as to support device configuration, control applications, and IoT without requiring the use of a system backbone.
- C. Wireless network shall be self-healing, such that the loss of backbone or local communication between devices does not result in the loss of control of the lights in the space.
- D. Wireless network communication shall support uniform and instant response such that all luminaires in a lighting control zone respond immediately and synchronously in response to a sensor or wall station signal.
- E. To support the system architecture requirement for distributed intelligence, wireless network communication shall support communication of control signals from sensors and wall stations to networked luminaires and wireless load control devices, without requiring any communication, interpretation, or translation of information through a backbone device such as a wireless access point, communication bridge or gateway.

- F. All wireless communication between lighting control components shall support the following five tiers of security measures.
 - 1. Data Encryption
 - 2. Firmware Protection
 - 3. Tamper-Proof Hardware
 - 4. Authenticated User Access
 - 5. Mutual Device Authentication
- G. Accounting for typical environmental conditions and building construction materials encountered within commercial indoor lighting environments, wireless networked devices shall be capable of communicating to at least 150' spacing between devices with embedded wireless transceivers under typical site conditions.
- H. Wireless networked devices shall have a line-of-sight communication range of at least 1000' under ideal environmental conditions.

I. Provide basis of design Wattstopper Legrand Wireless Gateway 225CWS and Nodes NWTL-211.

2.6 LINE VOLTAGE LIGHT SWITCHES

- A. Comply with NEMA WD 1 and UL 20.
- B. Industrial Grade Toggle Switches, 120/277 V, 20 A
 - Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
 - b. Hubbell; 1221 (single pole), 1222 (two pole), 1223 (three way), 1224 (four way).
 - c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
 - d. Pass & Seymour; Spec grade 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).
 - e. See plan for keyed switch, pilot options.
- C. Refer to drawings for key-switches when required.
- D. Refer to 26 27 26 Wiring Devices for device finish information.

2.7 LOW VOLTAGE SWITCHES

A. Product Description:

1.

- 1. Low voltage decorator-style push-button switch separate single or dual on/off buttons in one gang. Provide three-way switching, dimming, and wall sensors where indicated on plans.
- 2. Dimming switches: 0-10V decorator-style push-button switch with combined on/off button and separate up/down buttons on single gang. Engraving as required to match lighting details on plans.
- B. Refer to 26 27 26 Wiring Devices for device finish information.
- C. Connect to occupancy sensor(s) as indicated on plans and program as indicated on schedule found on plans. Programming is generally as follows:
 - 1. Typical applications (offices, conference rooms, etc): Manual-on, auto-off configuration.
 - 2. Toilets, maintenance closets, storage, etc: Auto-on, auto-off configuration.

2.8 WIRED NETWORKED GRAPHIC WALL STATIONS

- A. Surface-mounted device. Provide appropriate size backbox.
- B. Device shall have capacitive full color touch screen appropriately sized for number of scenes controlled.
- C. Device shall be powered with Class 2 low voltage supplied locally via a directly wired power supply.

- D. Device shall have a micro-USB style connector for local computer connectivity.
- E. Communication shall be over standard low voltage network cabling with RJ-45 connectors.
- F. Device shall enable user supplied screen saver image to be uploaded within one of the following formats: jpg, png, gif, bmp, tif.
- G. Device shall enable configuration of all switches, dimmers, control zones, and lighting preset scenes via password protected setup screens.
- H. Graphic wall stations shall support the following device options:
 - 1. Number of control zones: As required to accommodate number of zones noted on plans.
 - 2. Number of scenes: Up to 16.
 - 3. Profile type scene duration: User configurable from 5 minutes to 12 hours
 - 4. Colors: White, Black

2.9 OCCUPANCY/VACANCY SENSORS

- A. General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit:
 - 1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time-delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 - 2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
 - 3. Relay Unit / Power Pack: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70. Unit shall have low-voltage Teflon coated leads rated for plenum locations.
 - 4. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 - 5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
 - 6. Bypass Switch: Override the on function in case of sensor failure.
 - 7. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lx); keep lighting off when selected lighting level is present.
 - 8. High immunity to false triggering by RFI and EMI
 - 9. Separate 24 VAC dry contacts for EMCS connections.
 - 10. Have no leakage current to load, in manual or in Auto/Off mode, and have voltage drop protection.
 - 11. All sensors shall be dual occupancy/vacancy type.
- B. PIR Type: Ceiling mounting; detect occupancy by sensing a combination of heat and movement in area of coverage:
 - 1. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm).
 - 2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
 - 3. Detection Coverage (Corridor): Detect occupancy within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling.
- C. Ultrasonic Type / Microphonic: Ceiling mounting; detect occupancy by sensing a change in pattern of reflected ultrasonic energy in area of coverage:
 - 1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
 - 2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. (56 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
 - 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
 - 4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. (186 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.

- 5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling in a corridor not wider than 14 feet (4.3 m).
- D. Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit:
 - 1. Sensitivity Adjustment: Separate for each sensing technology.
 - 2. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
 - 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.

2.10 PHOTOELECTRIC SWITCHES

- A. Interior Switches:
 - 1. Ceiling-Mounted Photoelectric Switch: Solid-state, light-level sensor unit, with separate relay unit, to detect changes in lighting levels that are perceived by the eye. Cadmium sulfide photoresistors are not acceptable.
 - a. Sensor Output: Contacts rated to operate the associated relay, complying with UL 773A. Sensor shall be powered from the relay unit.
 - b. Relay Unit: Dry contacts rated for 20A ballast load at 120- and 277-V ac, for 13A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
 - c. Light-Level Monitoring Range: 10 to 200 fc (108 to 2152 lx), with an adjustment for turn-on and turn-off levels within that range.
 - d. Time-Delay: Adjustable from 5 to 300 seconds to prevent cycling, with deadband adjustment.
 - e. Indicator: Two LEDs to indicate the beginning of on-off cycles.
 - 2. Skylight Photoelectric Sensors: Solid-state, light-level sensor; housed in a threaded plastic fitting for mounting under skylight, facing up at skylight; with separate relay unit (mounted on luminaire), to detect changes in lighting levels that are perceived by the eye. Cadmium sulfide photoresistors are not acceptable.
 - a. Sensor Output: Contacts rated to operate the associated relay, complying with UL 773A. Sensor shall be powered from the relay unit.
 - b. Relay Unit: Dry contacts rated for 20A ballast load at 120- and 277-V ac, for 13A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
 - c. Light-Level Monitoring Range: 1000 to 10,000 fc (10 800 to 108 000 lx), with an adjustment for turn-on and turn-off levels within that range.
 - d. Time-Delay: Adjustable from 5 to 300 seconds to prevent cycling, with deadband adjustment.
 - e. Indicator: Two LEDs to indicate the beginning of on-off cycles.
- B. Exterior Switches:
 - 1. Description: Solid-state, with DPST dry contacts rated for 1800-VA tungsten, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.
 - a. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lx), with an adjustment for turn-on and turn-off levels within that range and a directional lens in front of photocell to prevent fixed light sources from causing turn-off.
 - b. Time Delay: 15-second minimum, to prevent false operation.
 - c. Surge Protection: Metal-oxide varistor, complying with IEEE C62.41.1, IEEE C62.41.2, and IEEE 62.45 for Category A1 locations.
 - d. Mounting: Twist-lock complying with IEEE C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

2.11 PLUG LOAD CONTROL

A. Utilize room lighting control system to control 120V receptacles with room occupancy. Lighting is 277V system. Not all controlled outlets in a space share the same circuit. Provide additional components and wiring as required. Refer to power plans for locations and circuiting requirements of controlled outlets.

2.12 WIRELESS NETWORKED DEVICES

- A. Wireless Networked Outdoor Occupancy and Photosensors
 - 1. Communication shall be provided by wireless BLE connection and 900MHz link to other devices.
 - 2. Sensor shall be available in both nipple mount and in-fixture mount options
 - a. Nipple mount sensor shall carry IP66 rating
 - b. In-fixture mount sensor shall carry IP65 rating
 - 3. Sensor shall be capable of operating in -40 to 65C ambient temperature ranges
 - 4. Sensors shall be capable of accepting 120-277, 347, or 480VAC input or DC power for embedded device.
 - 5. Occupancy sensors shall sense the presence of human activity within the desired space and fully control the on/off function of the lights.
 - 6. Sensors shall utilize passive infrared (PIR) technology, which detects occupant motion, to initially turn lights on from an off state, thus preventing false on conditions. Ultrasonic or Microwave based sensing technologies shall not be accepted.
 - 7. All sensors shall have the ability to detect when it is not receiving valid communication and blink its LED in a pattern to visually indicate a potential issue.
 - 8. Sensor programming parameter shall be available and configurable remotely from the software
 - 9. Nipple mounted sensors shall be available with multiple lens options available for various mounting heights
 - 10. Sensors shall have standard daylight photosensor for programmable daylight harvesting
 - 11. Photosensor shall provide foot-candle setpoint and a deadband to prevent the artificial light from cycling. Setpoint and deadband shall be capable of automatically calibrating through an "Automatic Set-Point Programming" procedure. Min and max dim settings as well as set-point may be manually entered.
 - 12. Deadband setting shall be verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., changes in car type and color, lamp outages).
 - 13. Devices shall include option for power interruption detection, where unit powers and controls the emergency circuit, and an interruption of power to this circuit for >30 ms forces unit to shunt closed, go to full bright, and ignore all system commands for 90 minutes.
- B. Wireless Networked Indoor Embedded Sensors
 - 1. Communication shall be provided by wireless BLE connection and 900MHz link to other devices.
 - 2. Network system shall have embedded sensors consisting of occupancy sensors and/or dimming photocells that can be embedded into luminaire such that only the lens shows on luminaire face.
 - 3. Occupancy sensor detection pattern shall be suitable for 7.5' to 40' mounting heights.
 - 4. Embedded sensors shall support the following configuration options:
 - a. Occupancy Sensing technology: PIR only or Dual Tech acoustic
 - b. Daylight Sensing Option: Occupancy only, Daylight only, or combination Occupancy/Daylight sensor
 - 5. Devices shall be available with options for both integrated and remote capable antennas such that devices can be optionally installed in a sealed container without detriment to wireless strength.
- C. Wireless Networked Luminaires
 - 1. Communication shall be provided by wireless BLE connection and 900MHz link to other devices.
 - 2. Networked luminaire shall have a mechanically integrated control device.
 - 3. System shall be able to turn on/off specific LED luminaires without using a relay, if LED driver supports "sleep mode."
 - 4. System shall be able to provide control of network luminaire intensity
- D. Wireless Networked Communication Adapter
 - 1. A communication adapter shall be provided that interfaces with the System Controller via USB connection and interfaces with wireless networked devices via 900MHz.
 - 2. Device shall be capable of communicating with at least 750 wireless networked devices and luminaires
 - 3. Device shall be supplied with mounting hardware suitable for vertical ceiling mounting or for vertical mounting from a wall.
 - 4. Device shall be unresponsive to wired and wireless communications that do not conform to the specific protocols used by the networked lighting control system.
 - 5. Device shall be IP66 rated and shall be optionally installed in an indoor or outdoor location.
 - 6. Device shall allow programming and control of indoor, outdoor, and industrial wireless control devices through a single user interface.

2.13 LIGHTING CONTACTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Lighting.
 - 2. Hubbell Lighting.
 - 3. Lithonia Lighting; Acuity Lighting Group, Inc.
 - 4. Watt Stopper (The).
- B. Description: Electrically operated and mechanically held, combination type with fusible switch, complying with NEMA ICS 2 and UL 508.
 - 1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
 - 2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
 - 3. Enclosure: Comply with NEMA 250.
 - 4. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.

2.14 EMERGENCY SHUNT RELAYS

- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Lighting Control and Design, Inc.
 - 2. Bodine GTD20A.
 - 3. Lutron Equal.
 - 4. Or equal.
- C. Description: Normally closed, electrically held relay, to automatically transfer from normal power circuit supply to the emergency power circuit supply and arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924. Verify all wiring contacts and connection requirements with manufacturer.

2.15 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

PART 3: EXECUTION

3.1 GENERAL INFORMATION

- A. Lighting control devices shall be installed in a neat and workmanlike manner. The NEIS Standard Practices for Good Workmanship in Electrical Contracting NECA 1-2006 is hereby adopted to define such workmanship and the installation of conductors and cables.
- B. System Installation shall be accomplished in a professional manner by qualified personnel regularly engaged in and experienced in this type of work. All wiring and devices shall be installed in accordance with manufacturer's and UL recommendations. Class II low-voltage occupancy sensor wiring in exposed areas shall be installed in metallic raceway. Class II low-voltage occupancy sensor wiring in concealed accessible areas that is not installed in conduit shall be plenum rated. All system junction boxes must be clearly marked for easy identification.

C. Wiring splices shall be avoided and, if needed, must be made only in junction boxes. All conductors shall be labeled on each end with "E-Z markers," or equivalent. Conductors in cabinets shall be carefully formed and harnessed so that each drops off directly opposite its terminal. Cabinet terminals shall be numbered and coded. All controls, function switches, etc., shall be clearly labeled on the equipment panel.

3.2 INSTALLATION REQUIREMENTS

- A. Installation Procedures and Verification
 - 1. The successful bidder shall review all required installation and pre-startup procedures with the manufacturer's representative through pre-construction meetings.
 - 2. The successful bidder shall install and connect the networked lighting control system components according to the manufacturer's installation instructions, wiring diagrams, the project submittals and plans specifications.
 - 3. The successful bidder shall be responsible for testing of all low voltage network cable included in the bid. Bidder is responsible for verification of the following minimum parameters:
 - a. Wire Map (continuity, pin termination, shorts and open connections, etc.)
 - b. Length
 - c. Insertion Loss
 - 4. Coordination with Owner's IT Network Infrastructure
 - a. The successful bidder is required to coordinate with the owner's representative to secure all required network connections to the owner's IT network infrastructure.
 - 1) The bidder shall provide to the owner's representative all network infrastructure requirements of the networked lighting control system.
 - 2) The bidder shall provide to the manufacturer's representative all necessary contacts pertaining to the owner's IT infrastructure, to ensure that the system is properly connected and started up.
 - 5. Documentation and Deliverables
 - a. The installing contractor shall be responsible for documenting installed location of all networked devices, including networked luminaires. This includes responsibility to provide as-built plan drawing showing device address barcodes corresponding to locations of installed equipment.
 - b. The installing contractor is also responsible for the following additional documentation to the manufacturer's representative if visualization / graphical floorplan software is provided as part of bid package:
 - 1) As-Built floor plan drawings showing device address locations required above. All documentation shall remain legible when reproducing\scanning drawing files for electronic submission.
 - 2) As-Built electrical lighting drawings (reflected ceiling plan) in PDF and CAD format. Architectural floor plans shall be based on as-built conditions.
 - a) CAD files shall have layers already turned on/off as desired to be shown in the graphical floorplan background images. The following CAD elements are recommended to be hidden to produce an ideal background graphical image:
 - Titleblock.
 - Text- Inclusive of room names and numbers, fixture tags and drawings notes.
 - Fixture wiring and homeruns.
 - Control devices.
 - Hatching or poché of light fixtures or architectural elements.

3.3 SYSTEM STARTUP

- A. Upon completion of installation by the installer, including completion of all required verification and documentation required by the manufacturer, the system shall be started up and programmed.
 - 1. For CAT5 wired devices, low voltage network cable testing shall be performed prior to system startup.
- B. System start-up and programming shall include:
 - 1. Verifying operational communication to all system devices.
 - 2. Programming the network devices into functional control zones to meet the required sequence of operation.
 - 3. Programming and verifying all sequence of operations.
- C. Initial start-up and programming is to occur on-site.

3.4 PROJECT TURNOVER

- A. System Documentation
 - 1. Submit software database file with desired device labels and notes completed. Changes to this file will not be made by the factory.
 - 2. Installing contractor to grant access to the owner for the programming database, if requested.

B. Owner Training

1. Provisions for onsite training for owner and designated attendees to be included in submittal package..

3.5 PLANNING / COORDINATION

- C. The Contractor shall arrange a *pre-installation* meeting with the lighting control device vendor(s), and an Owner's representative at the Owner's facility to verify placement of devices, installation criteria, and functionality.
- D. This Contractor shall attend the meeting to discuss the BACnet Work.

3.6 OCCUPANCY SENSOR INSTALLATION

- A. Installation Requirements:
 - 1. Sensors shown on plan are diagrammatic only. Occupancy sensor vendor shall design actual layout of devices and submit for shop drawings for review.
 - a. Rooms shall have 90% to 100% coverage of the designated controlled area to accommodate all occupancy habits of single or multiple occupants at any location with the room or area.
 - b. The locations and quantities of sensors shown on the drawings are diagrammatic and indicate only the rooms or areas which are to be provided with sensor protection.
 - c. Ensure the best possible installation (placement and quantity) in the available space and coordinate with local difficulties due to space limitations or interference of structural components.
 - d. Provide additional occupancy sensors in a room or space beyond that indicated if necessary to provide coverage required.
 - 2. Locate and aim sensors for complete and proper volumetric coverage per manufacturer's recommendations.
 - 3. Coordinate with installation and programming of low-voltage switches.

3.7 LIGHT LEVEL SENSOR INSTALLATION

A. Install and aim sensors north if possible, never south. Install pointing away from artificial sources of light.

3.8 CONTACTOR INSTALLATION

A. Mount electrically held lighting contactors with elastomeric isolator pads, to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.9 WIRING INSTALLATION

- A. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 1/2 inch (13 mm).
 - 1. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
 - 2. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
 - 3. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.10 IDENTIFICATION

- A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."
 - 1. Identify controlled circuits in lighting contactors.
 - 2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.
 - 3. Label contactors with a unique designation.

3.11 INSTALLATION OF EQUIPMENT BACnet INTERFACE DEVICES

- A. See Responsibility Matrix for the execution responsibilities for Equipment Supplier, Controls and Electrical Subcontractor.
- B. Equipment Supplier is responsible for supplying and installing the BACnet Interface Device.
- C. Division 25 is responsible for communicating with the BACnet Interface Device using BACnet objects and services to access this data and for mapping the BACnet objects from the device(s) in this Specification Section to the BACnet Object Integration Device to create graphics, reports, trends, alarms, schedules and other requirements specified in Division 25. Division 25 is only responsible for communicating with the BACnet Interface Device using BACnet objects and services to access this data.
- D. Electrical is responsible for power and any control wiring if the device does not have a single point of connection.
- E. This BACnet Interface Device is a BACnet/IP device. See Division 27 for networking responsibilities.

3.12 COORDINATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including luminaires, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

3.13 FIELD QUALITY CONTROL

- A. Field Wiring shall be checked and tested to ensure that there are no grounds, opens, or shorts. The minimum allowable resistance between any two conductors or between conductors and ground is 10 megohms after all conduit and conductors have been installed, but before the sensors are connected. Perform walk tests and set-up procedures for each sensor as specified by the manufacturer to ensure that all boundaries of coverage are sufficient.
- B. The Manufacturer's Representative shall submit a written test report that the system has been 100% tested, approved, and commissioned. The final test shall be witnessed by the Owner's representative, Electrical Engineer, Electrical Contractor, and performed by the manufacturer's representative. The final test report must be received and acknowledged by the Engineer prior to request for final payment. Perform all electrical and mechanical tests required by the equipment manufacturer. The installer shall prepare a checkout report and submit in triplicate, one copy of which will be registered with the equipment manufacturer. The report shall include, but not be limited to:
 - 1. Indication that lighting control devices are properly located, adjusted, (time-delay confirmed, aimed and sensitivity level determined) and communicating with desired load equipment.
 - 2. Indication that lighting control devices are functioning as determined by the specifications and as decided at the pre-installation meeting.
 - 3. Identification and replacement of lighting control devices that failed tests.
 - 4. Tests of individual areas as applicable.
 - 5. Installer's name and date.
- C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.14 WARRANTY

A. The Contractor shall provide parts and labor warranty for the completed occupancy sensor system wiring, equipment, and software to be free from inherent mechanical and electrical defects for a period of one year from the date of completion and acceptance as issued by the Architect's certificate of completion. The individual sensors shall have a five year warranty.

3.15 DEMONSTRATION

- A. Coordinate demonstration of products specified in this Section with demonstration requirements for any lighting control systems specified elsewhere in Division 26 Sections.
- B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices. Refer to Division 01 Section "Demonstration and Training." The training shall familiarize the Owner's personnel with the operation, use, adjustment, and problem solving diagnosis of the occupancy sensing devices and systems. Provide forms and schedules for organization and documentation of all system operating parameters.
- C. Refer to 25 20 26.09.23 for BACnet Interface Device demonstration, training and commissioning requirements.
- D. Film training of systems as part of closeout documents. Refer to 01 79 00 Demonstration and Training for specific information.

3.16 RECORD DRAWING DOCUMENTATION

- A. After successful completion of all the tests and adjustments listed above, the Contractor shall submit the following information to the Engineer in the Operation, Maintenance and Warranty Data Manuals:
 - 1. Complete As-Built Wiring Diagrams.
 - 2. System Operating Manuals.
 - 3. Copy of the Test Report, as detailed above.

END OF SECTION 26 09 23

SECTION 26 24 13

SWITCHBOARDS

PART 1: GENERAL

1.1 SCOPE

A. This Section includes the furnishing and installation of all labor, materials, tools, appliances, hardware, junction boxes, and ancillary equipment for and incidental to the delivery, installation, and furnishing of a completely operational switchboard as shown, required, and specified herein.

B. Section Includes:

- 1. Service and distribution switchboards rated 600 V and less.
- 2. Disconnecting and overcurrent protective devices.
- 3. Instrumentation.
- 4. Identification.
- 5. Concrete bases.
- 6. Extra materials.

1.2 RELATED SECTIONS

- A. Division 25 Section 25 20 26.24.13 Integrated Automation BACnet Interface Device (Gateways/Native BACnet Devices) Switchboards (All Types).
- B. 25 00 13 Integrated Automation General Requirements All Trades Work Responsibilities.
- C. Division 25 Schedule 3 BACNET SINGLE LINE DIAGRAM AND RESPONSIBILITY MATRIX (APPLIES TO ALL TRADES).

1.3 SUBMITTALS

- A. Product Data: For each type of switchboard, overcurrent protective device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
- B. Shop Drawings: For each switchboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Provide detail of enclosure types for types other than NEMA 250, Type 1.
 - 3. Provide detail of bus configuration, current, and voltage ratings.
 - 4. Provide detail of short-circuit current rating of switchboards and overcurrent protective devices.
 - 5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
 - 6. If service entrance equipment, provide detail of utility company's metering provisions with indication of approval by utility company.
 - 7. Disconnecting and overcurrent protective devices.
 - a. Provide detail of short-circuit current rating of switchboards and overcurrent protective devices.
 - b. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - c. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Include selectable ranges for each type of overcurrent protective device.
 - 8. Instrumentation.
 - 9. Accessory components and features.
 - 10. Identification. Provide schedule of nameplates.

- 11. BACnet Interface Device Submittal requirements.
 - a. Include the BACnet Interface Device with Submittal showing Modbus registers listed in 25 20 26.24.13 are mapped to BACnet Object Types. Failure to do so will result in automatic rejection of the submittal.
 - b. Provide compartmentalization information on the Submittal that shows that the 24 V connections from the Modbus device to the Trip Unit are provided at the factory and that all Modbus and BACnet equipment is in a separate switchboard compartment that only has 120 V and 24 V power.
- C. Selective Coordination Study: Provide preliminary selective coordination study with shop submittal, indicating circuit breakers coordinate with critical and life safety distribution systems. Identify potential conflicts and provide suggested solutions.
- D. Qualification Data: For qualified installer. (NFPA 70E training, Licensed Journeyman)
- E. Field Quality-Control Reports:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Test results of GFCI main current injection.
 - 4. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, maintenance and warranty data manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Routine maintenance requirements for switchboards and all installed components.
 - 2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - 3. Test Data: Results of thermal scan tests.
 - 4. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Include selectable ranges for each type of overcurrent protective device.
 - 5. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Submit record of transmittal as part of O&M Manual. Refer to "Extra Materials" article in Part 2 below.
 - 6. Submit record of warranty as part of O&M Manual. Refer to "Warranty" article in Part 3 below.

1.5 QUALITY ASSURANCE.

- A. The equipment manufacturer shall be regularly engaged in manufacture of power distribution switchboards, of the types and capacities required, and whose products have been in satisfactory use in similar service for not less than 25 years.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70 by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.
- D. Testing Agency Qualifications: Member of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- E. Source Limitations: Obtain switchboards, overcurrent protective devices, components, *panelboards, metering*, and accessories from single source from single manufacturer.

1.6 REFERENCES

- A. The products provided by this section shall comply with the following applicable references (latest edition):
 - 1. NECA 400 Standard for Installing and Maintaining Switchboards.
 - 2. NEMA AB-1 Molded Case Circuit Breakers.
 - 3. NEMA KS-1 Enclosed Switches.

- 4. NEMA PB 2 Dead Front Distribution Switchboards.
- 5. NEMA PB 2.1 Instructions for Safe Handling, Installation, Operation and Maintenance of Dead Front Distribution Switchboards Rated 600V or less.
- 6. NFPA 70E Standard for Electrical Safety in the Workplace.
- 7. NFPA 70 National Electrical Code
- 8. UL 198E Class R Fuses.
- 9. UL 860 Standard for Service Equipment.
- 10. UL 891 Standard for Dead Front Switchboards.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.
- B. Remove loose packing and flammable materials from inside switchboards and install temporary electric heating (250 W per section) to prevent condensation.
- C. Handle and prepare switchboards for installation according to NEMA PB 2.

1.8 PROTECTION

A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

1.9 PROJECT CONDITIONS

- A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.
- B. Environmental Limitations:
 - 1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 - 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding 104 deg F.
 - b. Altitude: Not exceeding 6600 feet.
- C. Service Conditions: NEMA PB 2, usual service conditions, as follows:
 - 1. Ambient temperatures within limits specified.
 - 2. Altitude not exceeding 6600 feet.
- D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

1.10 COORDINATION

- A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.11 MAINTENANCE

- A. Switchboard manufacturer / vendor shall:
 - 1. Make ordering of new equipment for expansions, replacements, and spare parts available to end user.
 - 2. Make new replacement parts available for minimum of ten years from date of manufacture.
 - 3. Provide factory direct technical support hotline 24 hours per day, 7 days per week.
 - 4. Provide on-site service support within 24 hours anywhere in continental United States.
 - 5. Offer renewable service contract on yearly basis, to include parts, factory labor, and annual training visits. Make service contracts available up to ten years after date of system commissioning.

1.12 WARRANTY

A. Warranty Period: Two years from date of Substantial Completion.

PART 2: PRODUCTS

2.1 GENERAL INFORMATION.

A. All electrical equipment and material shall be new and bear a recognized testing laboratory's label, where applicable. The type of equipment and/or material shall be designated by the location where it will be installed and so defined by NEMA / NFPA 70 standards.

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide switchboards by one of the following:
 - 1. Square D; a brand of Schneider Electric.
 - 2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 3. Siemens Energy & Automation, Inc.

2.3 SWITCHBOARD CONSTRUCTION AND RATINGS

- A. See drawings for voltage, current, and AIC ratings.
- B. Front-Connected, Front-Accessible ONLY Switchboards:
 - 1. Main Devices: Panel mounted.
 - 2. Branch Devices: Panel mounted.
 - 3. Sections front and rear aligned.
- C. Indoor Enclosures: Steel, NEMA 250, Type 1.
 - 1. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rustinhibiting primer on treated metal surface.
- D. Outdoor Enclosures (where indicated): Type 3R.
 - 1. Finish: Finish and color selected by Architect from manufacturer's standard palette. Factory-applied finish; undersurfaces treated with corrosion-resistant undercoating.
 - 2. Enclosure: Downward, rearward sloping roof; bolt-on rear covers for each section, with provisions for padlocking.
 - 3. Doors: Personnel door at each end of aisle, minimum width of 30 inches; opening outwards; with panic hardware and provisions for padlocking.
 - 4. Cubical Space Heaters: Factory-installed electric space heaters of sufficient wattage in each vertical section to maintain enclosure temperature above expected dew point.
 - a. Space-Heater Control: Thermostats to maintain temperature of each section above expected dew point.
 - b. Space-Heater Power Source: Transformer, factory installed in switchboard.

- E. Customer Metering Compartment (where indicated): A separate customer metering compartment and section with front hinged door, for indicated metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks. If necessary include potential transformers having primary and secondary fuses with disconnecting means and secondary wiring terminated on terminal blocks.
- F. Bus Transition and Incoming Pull Sections as required for underground supply: Matched and aligned with basic switchboard.
- G. Removable, Hinged Rear Doors and Compartment Covers:
 - 1. Required for rear-access switchboards only.
 - 2. Secured by captive thumb screws, for access to rear interior of switchboard.
- H. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
- I. Buses and Connections: Three phase, four wire unless otherwise indicated.
 - 1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity, with tin-plated aluminum or copper feeder circuit-breaker line connections.
 - 2. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with compression connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.
 - 3. Ground Bus: 1/4-by-2-inch- hard-drawn copper of 98 percent conductivity, equipped with compression connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
 - 4. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
 - 5. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with compression connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
- J. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.
- K. Separate compartment for BACnet and Modbus devices that only has 120 V and 24 V power. Provide conduit to allow for an IP connection to the BACnet/IP device to be made.

2.4 VISUALIZATION DEVICE MOUNTED ON SWITCHBOARD

- A. Where indicated provide switchboard-mounted visualization device.
 - 1. Maintenance mode that allows remote enabling/disabling of electronic trip units.
 - 2. Setpoint mode that allows set point viewing and programming including settings file management.
 - 3. Control mode that provides open/close control of circuit breaker trip units.
- **B.** Eaton **PXDBL PXDL** or equivalent. 21" HMI screen shall be mounted to switchboard. Provide the following graphics customized for the Place of the Work:
 - 1. Elevation view of all devices as they appear in the switchboards.
 - 2. One-Line Diagram showing as-built conditions.
 - 3. Access to each device on a single graphic screen c/w the points in that device.
 - 4. Transfer Scheme for the equipment.
 - 5. Allow for 50 internal trends of the Owner's choosing.
 - 6. Allow for 50 setpoints of the Owner's choosing.
 - 7. Allow for 50 alarms of the Owner's choosing.
 - 8. Allow for 16 hours on on-site training and commissioning time. This is in excess of any other training and commissioning work in this Specification Section.
 - 9. Allow for 4 hours of time to commission and test the BACnet/IP connection with the Owner's BAS Consultant.

2.5 SURGE PROTECTIVE DEVICE

- A. Provide SPD Protection (at services, COPS and life safety switchboards, and where indicated); see Specification Section 26 43 13 and 25 25 26.43.13 for requirements.
- B. Include 60A overcurrent protection device within switchboard as a dedicated disconnecting means for SPD unless explicitly noted otherwise.

2.6 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES – MAIN

- A. Main disconnecting and overcurrent protective devices used as service equipment shall be listed and labeled for such use.
- B. Main Lug Only (MLO): where indicated.
- C. Main Circuit Breaker (MCB): where indicated.
 - 1. Comply with IEEE C37.13.
 - 2. Ratings: Continuous ampacity as indicated on plans. Interrupting and short-time current ratings for each circuit breaker as indicated on plans. Voltage and frequency ratings same as switchgear.
 - 3. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Basis of Design: Square D Micrologic Type H/P/E trip units with power metering. Refer to riser diagrams and schedules for specific breaker requirements.
 - b. Or equal of:
 - 1) ABB.
 - 2) Eaton.
 - 3) Siemens.
 - 4. Operating Mechanism: Mechanically and electrically trip-free, stored-energy operating mechanism with the following features:
 - a. Normal Closing Speed: Independent of both control and operator.
 - b. Slow Closing Speed: Optional with operator for inspection and adjustment.
 - c. Stored-Energy Mechanism: Electrically charged, with optional manual charging.
 - d. Operation counter.
 - 5. Trip Devices: Solid-state, over-current trip-device system consisting of one or two current transformers or sensors per phase, a release mechanism, and the following features:
 - a. Functions: Long-time-delay, short-time-delay, and instantaneous-trip functions, independent of each other in both action and adjustment.
 - b. Temperature Compensation: Ensures accuracy and calibration stability from minus 5 to plus 40 deg C.
 - c. Field-adjustable, time-current characteristics.
 - d. Current Adjustability: Dial settings and rating plugs on trip units or sensors on circuit breakers, or a combination of these methods.
 - e. Three bands, minimum, for long-time- and short-time-delay functions; marked "minimum," "intermediate," and "maximum."
 - f. Pickup Points: Five minimum, for long-time- and short-time-trip functions. Equip short-time-trip function for switchable I2t operation.
 - g. Pickup Points: Five minimum, for instantaneous-trip functions.
 - h. Ground-Fault Relay:
 - 1) Provide at all equipment rated 480V, 1000A or more, or where indicated on plans.
 - Provide protection with at least three short-time-delay settings and three trip-time-delay bands; adjustable current pickup. Arrange to provide protection for the following:

 a) Four-wire circuit or system.
 - i. Trip Indication:
 - 1) Labeled, battery-powered lights or mechanical targets on trip device to indicate type of fault.
 - 2) Provide an LCD screen on each Trip Unit to permit the display of all data in the Trip Unit.
 - j. Frame sizes 1200A or larger shall include arc reduction maintenance switch function imbedded to meet NEC 240.87.
 - 6. Integral Power Metering:
 - a. With intergral power measurement, power quality measurements, and waveform capture.

- b. All metering, monitoring and history logs are functional.
- c. Communications from trip unit to programmable contact modules are powered by an external 24 Vdc supply.
- 7. Auxiliary Contacts (where indicated): For interlocking or remote indication of circuit-breaker position, with spare auxiliary switches and other auxiliary switches required for normal circuit-breaker operation, quantity as indicated. Each consists of two Type "a" and two Type "b" stages (contacts) wired through secondary disconnect devices to a terminal block in stationary housing.

2.7 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES – DISTRIBUTION

- A. Molded-Case Circuit Breaker (CB, where indicated): Comply with UL 489, with interrupting capacity to meet available fault currents. Frame sizes 1200A or larger shall include arc reduction maintenance switch function to meet NEC 240.87.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Basis of Design: Square D Micrologic Type H/P/E trip units with power metering. Refer to riser diagrams and schedules for specific breaker requirements.
 - Or equal of:

b.

- 1) ABB.
- 2) Eaton.
- 3) Siemens.
- 2. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I²t response.
- 3. GFCI Circuit Breakers (where indicated): Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
- 4. Ground-Fault Equipment Protection (GFEP) Circuit Breakers (where indicated): Class B ground-fault protection (30-mA trip).
- 5. Integral Power Metering:
 - a. With intergral power measurement, power quality measurements, and waveform capture.
 - b. All metering, monitoring and history logs are functional.
 - c. Communications from trip unit to programmable contact modules are powered by an external 24 Vdc supply.
- 6. Molded-Case Circuit-Breaker (CB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
 - c. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
 - d. Auxiliary Contacts (where indicated): One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.

2.8 INSTRUMENTATION

- A. Manufacturer: Schneider PM8000 w/ Sag/Swell option, or approved equal.
- B. Multifunction Digital-Metering Monitor (where indicated): Microprocessor-based unit suitable for three- or fourwire systems and with the following features:
 - 1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
 - a. Phase Currents, Each Phase: Plus or minus 1 percent.
 - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
 - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
 - d. Megawatts: Plus or minus 2 percent.
 - e. Megavars: Plus or minus 2 percent.
 - f. Power Factor: Plus or minus 2 percent.
 - g. Frequency: Plus or minus 0.5 percent.

- h. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.
- i. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from five to 60 minutes.
- j. Contact devices to operate remote impulse-totalizing demand meter.
- 2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.
- 3. Provide BACnet Interface Devices for each trip unit and meter in the switchboard so that the units are presented as a series of AV, BV and MSV BACnet objects. See 25 20 26.24.13 for the list of objects that must be supported. This list is the minimum acceptable.
- 4. Integrate into Building Automation System. Refer to Div 25 for requirements.

2.9 CONCRETE BASES

- A. Equipment Mounting: Install switchboards on concrete base, 4-inch nominal thickness. Comply with requirements for concrete base specified in Division 03 Section.
 - 1. Coordinate size of equipment bases with actual unit sizes provided. Fabricate base 4 inches larger in both directions than the overall dimensions of the supported unit. Chamfer top edge and corners of pad.
 - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 - 3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 5. Install anchor bolts to elevations required for proper attachment to switchboards.

2.10 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Keys: Two spares for each type of switchboard cabinet lock (if present).
 - 2. Spare Circuit Breakers shall be as shown on Drawings.

PART 3: EXECUTION

3.1 GENERAL INSTALLATION

- A. Switchboards shall be installed in a neat and workmanlike manner. The NEIS Standard Practices for Good Workmanship in Electrical Contracting NECA 1-2006 is hereby adopted to define such workmanship and the installation of conductors and cables.
- B. Provide all equipment, wiring, conduit, and junction boxes required for the installation of a complete and operating system in accordance with applicable local, state, and national codes, the manufacturers' recommendations, these plans and specifications.
- C. Panels shall be used for the voltage of which they are designed. The use of 480/277V panels on lesser voltages is not allowed.

3.2 INSTALLATION OF BACNET INTERFACE DEVICES

- A. See Responsibility Matrix for the execution responsibilities for Equipment Supplier, Controls and Electrical Subcontractor.
- B. Equipment Supplier is responsible for supplying and installing the BACnet Interface Device.

- C. Division 25 is responsible for communicating with the BACnet Interface Device using BACnet objects and services to access this data and for mapping the BACnet objects from the device(s) in this Specification Section to the BACnet Object Integration Device to create graphics, reports, trends, alarms, schedules and other requirements specified in Division 25. Division 25 is only responsible for communicating with the BACnet Interface Device using BACnet objects and services to access this data.
- D. Electrical is responsible for power and any control wiring if the device does not have a single point of connection.
- E. This BACnet Interface Device is a BACnet/IP device. See Division 27 for networking responsibilities.

3.3 EXAMINATION

- A. Receive, inspect, handle, and store switchboards according to NEMA PB 2.1.
- B. Examine switchboard(s) before installation. Reject switchboards that are moisture damaged or physically damaged.
- C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.4 INSTALLATION

- A. Install switchboards and accessories according to NEMA PB 2.1.
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.
- C. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
- D. Install filler plates in unused spaces of panel-mounted sections.
- E. Install overcurrent protective devices and instrumentation.1. Set field-adjustable switches and circuit-breaker trip ranges.
- F. Install surge protection as specified in related sections.
- G. Comply with NECA 1.

3.5 CONNECTIONS

A. Comply with requirements for terminating feeder bus specified in Division 26 Section "Enclosed Bus Assemblies." Drawings indicate general arrangement of bus, fittings, and specialties.

3.6 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- B. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

- C. Switchboard Nameplates:
 - 1. Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems".
 - 2. Label service entrance switchboards with available fault current information as well as the date the fault calculation was performed. Do not use fault current rating of equipment for this value. If value is not readily available on plans obtain from project engineer, or if applicable from engineer as specified in 260573 "Overcurrent Protective Device Coordination Study".
- D. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.7 GROUND FAULT EQUIPMENT PROTECTION PERFORMANCE TESTING

- A. Notify commissioning agent in advance of performing tests and inspections.
- B. Testing Agent: Engage a testing agent or factory-authorized service representative to perform tests. Report results in writing.
- C. Tests and Inspections:
 - 1. Perform current injection test on GFEP main breaker per NEC 230.95.
 - 2. Perform current injection test on Critical Care GFEP breakers per NEC 510.17.
 - 3. Test shall be witnessed by electrical inspector or written record provided; confirm electrical inspector. Contractor shall schedule test.
 - 4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Switchboard will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes testing results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.8 INFRARED SCANNING

- A. Notify commissioning agent in advance of performing tests and inspections.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 3. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front panels (and rear, where applicable) so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
 - c. Instruments and Equipment:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

- 4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Switchboard will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.9 ADJUSTING AND CLEANING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Upon completion of installation of switchboard, de-energize equipment and inspect interiors of switchboard; clear all blockages and remove burrs, paint splatters and other spots, dirt, and construction debris. Touch up scratches and mars of finish to match original finish.
- C. Adjust Circuit Breaker trip and time-delay settings to values as instructed by the Architect/Engineer.

3.10 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories.
- B. Refer to 25 20 26.24.13 for BACnet Interface Device demonstration, training and commissioning requirements.
- C. Film training of systems as part of closeout documents. Refer to 01 79 00 Demonstration and Training for specific information.

END OF SECTION 26 24 13

SECTION 26 24 16

PANELBOARDS

PART 1: GENERAL

1.1 SCOPE

- A. Section Includes:
 - 1. Lighting and appliance branch-circuit panelboards.
 - 2. Electronic-grade surge-suppression panelboards.
- B. This Section includes the furnishing and installation of all labor, materials, tools, appliances, hardware, junction boxes, and ancillary equipment for and incidental to the delivery, installation, and furnishing of completely operational panelboards as shown, required, and specified herein.

1.2 SUBMITTALS

- A. Provide product data for each type of panelboard, switching and overcurrent protective device, accessory, and component indicated.
- B. Shop Drawings shall be submitted for each panelboard; including:
 - 1. Include dimensioned plans, elevations, and details, including required wiring space / gutter clearances.
 - 2. Provide current and voltage ratings.
 - 3. Provide short-circuit current rating of overcurrent protective devices.
 - 4. Provide panelboard ancillary equipment options, including hinged trim, feed thru lugs, shunt-trip breakers, GFCI, etc. See schedules for specific requirements.
 - 5. Panelboard schedules.
- C. Selective Coordination Study: Provide preliminary selective coordination study with shop submittal, indicating circuit breakers coordinate with critical and life safety distribution systems. Identify potential conflicts and provide suggested solutions.
- D. Field Quality Control Reports:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- E. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, maintenance and warranty data manuals. In addition to items specified in Division 01 Section "Operation, Maintenance and Warranty Data," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - 2. Test Data: Results of thermal scan tests.
 - 3. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

F. Include the BACnet Interface Device with Submittal showing proprietary points listed in 25 26 23.24.16 are mapped to BACnet Object Types. Failure to do so will result in automatic rejection of the Submittal

1.3 QUALITY ASSURANCE

- A. Manufacturer of panelboards shall be specialized in the manufacture and assembly of such equipment for a minimum of 25 years.
- B. Equipment shall be listed and/or classified by Underwriters Laboratories and in accordance with standards listed in this Specification.
- C. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 1.1 and trained in electrical safety as required by NFPA 70E.

D. Source Limitations: Obtain panelboards, overcurrent protective devices, components, *switchboards, metering,* and accessories from single source from single manufacturer.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; if storage conditions require it install temporary electric heating (250 W per panelboard) to prevent condensation.
- B. Handle and prepare panelboards for installation according to NECA 407.

1.5 PROJECT CONDITIONS

- A. Environmental Limitations:
 - 1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 - 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature:
 - 1) For panels with fused switches: Not exceeding minus 22 deg F to plus 104 deg F.
 - 2) For panels with circuit breakers: Not exceeding 23 deg F to plus 104 deg F.
 - b. Altitude: Not exceeding 6600 feet.
- B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
 - 1. Ambient temperatures within limits specified.
 - 2. Altitude not exceeding 6600 feet.

1.6 REFERENCES

- A. The products provided by this section shall comply with the following applicable references (latest edition):
 - 1. NEMA AB 1 Molded Case Circuit Breakers.
 - 2. NEMA KS 1 Enclosed Switches.
 - 3. NEMA PB 1 Panelboards.
 - 4. NEMA PB 1.1 Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600V or Less.
 - 5. UL 489 Molded Case Circuit Breakers.
 - 6. UL 1047 Isolated Power System Distribution Equipment

1.7 MAINTENANCE

- A. Panelboard manufacturer / vendor shall:
 - 1. Make ordering of new equipment for expansions, replacements, and spare parts available to end user.
 - 2. Make new replacement parts available for minimum of ten years from date of manufacture.
 - 3. Provide factory direct technical support hotline 24 hours per day, 7 days per week.
 - 4. Provide on-site service support within 24 hours anywhere in continental United States.
 - 5. Offer renewable service contract on yearly basis, to include parts, factory labor, and annual training visits. Make service contracts available up to ten years after date of system commissioning.

1.8 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.9 RELATED SECTIONS

- A. Section 25 20 26.24.16 Integrated Automation BACnet Interface Device (Gateway/Native BACnet Devices) Panelboards (All Types). The BACnet Interface Device Work only applies to 26 24 16 if an addressable breaker panelboard is being used for relay lighting control.
- B. Section 25 00 13 Integrated Automation General Requirements All Trades Work Responsibilities.
- C. Division 25 Schedule 3 BACnet Single Line Diagram and Responsibility Matrix (Applies to all Trades).

PART 2: PRODUCTS

2.1 GENERAL INFORMATION.

A. All electrical equipment and material shall be new and bear a recognized testing laboratory's label, where applicable. The type of equipment and/or material shall be designated by the location where it will be installed and so defined by NEMA / NFPA 70 standards.

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide panelboards by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. Siemens Energy & Automation, Inc.
 - 3. Square D; a brand of Schneider Electric.

2.3 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Enclosures: Flush- and surface-mounted cabinets.
 - Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - b. Outdoor Locations: NEMA 250, Type 3R.
 - c. Kitchen/Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
 - d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 - e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 5.
 - 2. Finishes:

1.

- a. Panels and Trim: Steel or galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
- b. Back Boxes: Same finish as panels and trim.
- 3. Panelboard Cover: Entire front trim hinged to box with piano style hinges, and with standard door within hinged trim cover.
- 4. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.
- B. Incoming Mains Location: Top or bottom (contractor's discretion).
- C. Phase, Neutral, and Ground Buses:
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - 2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
 - 3. Neutral Bus:
 - a. Normally rated 100 percent of phase bus unless otherwise indicated.
 - b. Extra-Capacity Neutral Bus (for electronic grade panelboards and where otherwise indicated): Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.
- D. Conductor Connectors: Suitable for use with conductor material and sizes.
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - 2. Main and Neutral Lugs: Mechanical type.
 - 3. Ground Lugs and Bus-Configured Terminators: Mechanical type.

- 4. Feed-Through Lugs (where indicated): Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
- 5. Subfeed (Double) Lugs (where indicated): Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
- 6. Extra-Capacity Neutral Lugs (for electronic grade panelboards and where otherwise indicated): Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
- E. Service Equipment Label (where indicated): NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices. Only applicable to panels used as service entrance equipment, coordinate with plans.
- F. Provisions for Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- G. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Provide 65kAIC unless noted otherwise.
- H. See drawings for voltage, current, AIC ratings, flush or surface mounting, schedules, nameplates, environmental conditions, MLO, feed-thru lugs, future space / spare / overcurrent devices, etc.
- I. Provide BACnet Interface Devices for each Panelboard so that the units are presented as a series of AV, BV and MSV BACnet objects. See 25 20 26.24.16 for the list of objects that must be supported. This list is the minimum acceptable.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. The following general requirements apply to all lighting and appliance branch-circuit panelboards:
 - 1. Factory assembled and dead front safety type.
 - 2. Bolt-on breakers unless otherwise noted.
 - 3. With adequate wire bending space based on maximum overcurrent device capable of being installed.
 - 4. Pre-knocked out panelboard tops or bottoms shall not be permitted.
 - 5. Hinged trim (door-in-door) type unless otherwise noted.
 - 6. Trims:
 - a. Flush trims: concealed clamp and hinges, flush lock, and primer finish.
 - b. Surface: factory painted in manufacturer's standard color.
 - 7. If containing breakers that serve as sole disconnecting means, provide permanent means to lock breakers open.
 - 8. Field verify incoming feeder location for each panelboard.
 - 9. Provide typed directory card inside panelboard door, mounted in metal frame with transparent protective cover.
 - 10. If doors more than 48" high, have vault-type latch. Otherwise, have flush latch. Latches shall be keyed alike.
 - 11. Surge Protection Device (where indicated and required for all life safety panels): Integrally mounted, plug-in, solid-state, parallel-connected type as specified in Section 26 24 13 "Surge Protective Devices for Low-Voltage Electrical Power Circuits".
- B. Electronic-Grade Panelboards (where indicated and required for all COPS and life safety panels):
 - 1. Panelboards: NEMA PB 1; with factory-installed, integral surge suppression; labeled by an NRTL for compliance with UL 67 after installing surge suppression.
 - 2. Buses:
 - a. Copper phase and neutral buses; 200 percent capacity neutral bus and lugs.
 - b. Copper equipment and isolated ground buses.
 - 3. Surge Protection Device: Integrally mounted, plug-in, solid-state, parallel-connected type as specified in Section 26 24 13 "Surge Protective Devices for Low-Voltage Electrical Power Circuits".

2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. See drawings for voltage, current, AIC ratings, GFCI, GFPE, Shunt-Trip, Handle Ties, Lock-On/Offs, switch rated, etc.

- B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents:
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 - 3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I²t response.
 - 4. Current-Limiting Circuit Breakers: Frame sizes 400 Å and smaller; let-through ratings less than NEMA FU 1, RK-5.
 - 5. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
 - 6. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
 - 7. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Suitable for number, size, trip ratings, and conductor materials.
 - c. Ground-Fault Protection: Integrally mounted relay and trip-unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - d. Arc reduction maintenance switch function to meet NEC 240.87 for breaker frame sizes 1200 A and larger.

PART 3: EXECUTION

3.1 GENERAL INSTALLATION

- A. Panelboards shall be installed in a neat and workmanlike manner. The NEIS Standard Practices for Good Workmanship in Electrical Contracting NECA 1-2006 is hereby adopted to define such workmanship and the installation of conductors and cables.
- B. Provide all equipment, wiring, conduit, and junction boxes required for the installation of a complete and operating system in accordance with applicable local, state, and national codes, the manufacturers' recommendations, these plans and specifications.
- C. Panels shall be used for the voltage of which they are designed. The use of 480/277V panels on lesser voltages is not allowed.
- **D.** Installation of BACnet Interface Device
 - 1. See the Division 25 Responsibility Matrix for the execution responsibilities for Equipment Supplier, Controls and Electrical Subcontractor.
 - 2. The supplier is responsible for supplying and installing the BACnet Interface Device."
 - 3. Electrical is responsible for power and any control wiring if the device does not have a single point of connection.
 - 4. Division 25 is responsible for communicating with the BACnet Interface Device using BACnet objects and services to access this data and for mapping the BACnet objects from the device(s) in this Specification Section to the BACnet Object Integration Device to create graphics, reports, trends, alarms, schedules and other requirements specified in Division 25.
 - 5. This BACnet Interface Device is a BACnet/IP device. See Division 25 for networking responsibilities.

3.2 PROJECT CONDITIONS

- A. Environmental Limitations:
 - 1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 - Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.

3.3 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

3.4 INSTALLATION OF PANELBOARDS

- A. Mount panelboards and cabinets to building structure or interior wall construction. Mount independent of conduit and raceways entering boxes. Where indicated, provide free standing Plywood/Unistrut backboards (painted with fire retardant grey) rigidly mounted to the floor and/or ceiling for panelboard support means.
- B. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- C. Mount panelboards with cabinet top at 78" above finished floor.
- D. Provide 1" spare empty conduits from each flush mounted panelboard. When the floor is on grade, provide three (3) conduits into the ceiling cavity above. When the floor has accessible space below, provide two (2) conduits into the ceiling cavity above and two (2) conduits into the accessible space below the floor. Ends shall be capped and shall be tagged at both ends with permanent tags.
- E. Provide three spare empty 1" conduits from surface mounted panelboard into accessible ceiling space or space designated to be ceiling space.
- F. Provide each circuit in the panel(s) with a circuit number securely fastened to the breaker for identification purposes.
- G. Provide a circuit directory dated and completely typed on the interior of each panel door.
- H. Verify with owner critical circuits, for application of "lock-ons". (Telecommunication circuits, Fire Alarm, Security, HVAC, etc.)
- I. Install filler plates in unused spaces.
- J. Comply with NECA 1.

3.5 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads. Use template indicated at the end of this specification section.
 - 1. Incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
 - 2. Provide 8x11 panel directory in 8x11 plastic sleeve. Secure sleeve to inside cover of panelboard with appropriate materials.
 - 3. Free template (Excel format) is available upon request from engineer for contractor's use.
 - 4. Coordinate with engineer for fault current and date of study.

- 5. Document accurate feeder lengths (within 10') as best possible.
- 6. For existing panels requiring addition of more than five circuits field verify all information as reasonably possible.
- 7. Submit final copy of each directory as part of O&M Manual.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.6 FIELD QUALITY CONTROL

- A. Notify commissioning agent in advance of performing tests and inspections.
- B. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- C. Inspect Completed Installation for physical damage, proper alignment, anchorage, and grounding.
- D. Measure, using a Megger, the insulation resistance of each bus section phase-to-phase and phase-to-ground for one minute each, at minimum test voltage of 1000 VDC; minimum acceptable value for insulation resistance is 1 megohms. NOTE: Refer to manufacturer's literature for specific testing procedures.
- E. Check Tightness of accessible bolted bus joints using calibrated torque wrench per manufacturer's recommended torque values.
- F. Test Ground Fault Systems by operating push-to-test button.
- G. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 3. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
 - c. Instruments and Equipment:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 4. Include test results in Operation, Maintenance and Warranty Data Manuals.
- H. Balancing Loads: After Substantial Completion, but not more than two months after Final Acceptance, conduct load-balancing measurements and make circuit changes as follows:
 - 1. Perform measurements during period of normal working load as advised by the Owner.
 - 2. Perform load-balancing circuit changes outside the normal occupancy/working schedule of the facility. Make special arrangements with Owner to avoid disrupting critical 24-hour services such as FAX machines and on-line data processing, computing, transmitting, and receiving equipment.
 - 3. Recheck loads after circuit changes during normal load period. Record all load readings before and after changes and submit test records.
 - 4. Tolerance: Difference between phase loads exceeding 20 percent within any one panelboard is not acceptable. Re-balance and re-check as required to meet this minimum requirement.

3.7 ADJUSTING AND CLEANING

- A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.
- B. Adjust Circuit Breaker trip and time-delay settings to values as instructed by the Architect/Engineer.
- C. Upon completion of installation of panelboard, de-energize equipment and inspect interiors of panelboard; clear all blockages and remove burrs, paint splatters and other spots, dirt, and construction debris. Touch up scratches and mars of finish to match original finish.

3.8 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain panelboards, overcurrent protective devices, and accessories. Include a 4 hour session.
- B. Film training of systems as part of closeout documents. Refer to 01 79 00 Demonstration and Training for specific information.
- C. Refer to 25 08 01, 25 08 02 and 25 20 26.24.16 for start-up, commissioning and training requirement for the BACnet Interface Devices provided in this Specification Section

3.9 WARRANTY

A. The Contractor shall provide a <u>one-year warranty</u> of the installed system against defects in material and workmanship. All labor and materials shall be provided at no expense to the Owner. Warranty period shall begin on the date of acceptance as issued by the Architect's certificate of completion.

3.10 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Keys: Two spares for each type of panelboard cabinet lock.
 - 2. Spare Circuit Breakers shall be as shown on Drawings.

END OF SECTION 26 24 16

SECTION 26 27 13

ELECTRICITY METERING

PART 1: GENERAL

1.01 SUMMARY

A. This Section includes a complete electrical energy management system for electricity metering of plug load panelboards. System shall have a web based monitoring system that monitors all specified locations in the distribution system and is capable of performing calculations, generating reports and interfacing with third party equipment.

1.02 RELATED SECTIONS

- A. Division 25 Section 25 20 26.27.13 Integrated Automation BACnet Interface Device (Gateways/Native BACnet Devices) Electricity Metering Equipment (All Types).
- B. 25 00 13 Integrated Automation General Requirements All Trades Work Responsibilities.
- C. Division 25 Schedule 3 BACNET SINGLE LINE DIAGRAM AND RESPONSIBILITY MATRIX (APPLIES TO ALL TRADES).

1.03 SUBMITTALS

- A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes. Describe electrical characteristics, features, and operating sequences, both automatic and manual. Include the following:
 - 1. Electricity-metering equipment.
- B. Shop Drawings for Electricity-Metering Equipment:
 - 1. Dimensioned plans and sections or elevation layouts.
 - 2. Wiring Diagrams: Power, signal, and control wiring specific to this Project. Identify terminals and wiring designations and color codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features.
 - 3. Include floorplan to indicate location of each meter, name and load it serves.
 - 4. System description including an overview of the system provided with detailed description of suggested communication architecture and the screens to be provided.
 - 5. Bill of Material including a complete listing of all hardware, software, configuration, training and start-up services being supplied under this contract.
 - 6. Hardware and software description shall be provided in detail for all communications hardware, software, including sensor devices gathering data to be transmitted over the network and the Power Management Engineering Station.7.Details of the Power Quality analysis or waveform capture features supported in the software.
 - 7. Include the BACnet Interface Device with Submittal showing proprietary points listed in 25 20 26.27.13 are mapped to BACnet Object Types. Failure to do so will result in automatic rejection of the submittal.
- C. Operation and Maintenance Data: For electricity-metering equipment to include in emergency, operation, and maintenance manuals.

1.04 QUALITY ASSURANCE

A. 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.

B. Source Limitations: Obtain switchboards, overcurrent protective devices, components, panelboards, metering, and accessories from single source from single manufacturer.

1.05 COORDINATION

A. Comply with Division 27 for communications cabling.

PART 2: PRODUCTS

2.01 EQUIPMENT FOR ELECTRICITY METERING BY OWNER

- A. Manufacturers: Subject to compliance with requirements, provide *Eaton Power Xpert Energy Visual and Analytics PX-EVA* Siemens SEM3 with WinPM software or approved products by one of the following:
 - 1. Square D; Schneider Electric.
 - 2. Siemens Eaton.
 - 3. Approved Equal.
- B. Kilowatt-Hour/Demand Meter: Electronic single- and three-phase meters, measuring electricity use and demand.
 - 1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.
 - 2. Display: Digital liquid crystal, indicating accumulative kilowatt hours, current time and date, current demand, historic peak demand, and time and date of historic peak demand.
 - 3. Web-based software to allow review of historic and real time data. Selectable demand interval from five to 60 minutes.
 - 4. Demand Signal Communication Interface: Match signal to remote building automation system input and arrange to convey the instantaneous, integrated, demand level measured by meter to provide data for processing and possible programmed demand control action by destination system.
 - a. Ethernet port for connection to variety of protocols. Provide data connection to building network and Building Automation System (BAS).
 - 5. Programmable Contact Module: Unit shall have push-button switches and a display for setting the demand level at which an integral set of Form C contacts shall be operated to initiate indicated action.
 - 6. Enclosure: NEMA 250, Type 1 minimum, with hasp for padlocking or sealing. Or integral within panel board enclosure.
 - 7. Identification: Comply with Division 26 Section "Identification for Electrical Systems." Name each meter per the panel it serves.
 - 8. Memory Backup: Self-contained to maintain memory throughout power outages of 72 hours, minimum.
 - a. Minimum 128 MB for 24 month log.
 - 9. Sensors: Current-sensing type, with current or voltage output, selected for optimum range and accuracy for ratings of circuits indicated for this application.
 - a. Type: Split or solid core.
 - 10. Meter Accuracy: Nationally recognized testing laboratory certified to comply with ANSI.
 - a. Accuracy of +/-0.1% or better for voltage and amperes, and 0.2% for power and energy functions.
 - 11. Provide BACnet Interface Devices for each piece of Energy Metering Equipment so that the units are presented as a series of AV, BV and MSV BACnet objects. See 25 20 26.27.13 for the list of objects that must be supported. This list is the minimum acceptable.
- C. Energy Information Management Software:
 - 1. Be designed to run on Microsoft Windows platform and have editing to facilitate the programming and monitoring of the system. Allow the monitoring of vital system parameters and provide a scalable system for future expansions without replacement of the system hardware or software.
 - 2. Have web client to allow authenticated access to information using standard web browsers. No control is allowed in the Web client. Accessible information includes tables, trends, reports and alarms.
 - 3. Shall be capable of showing all parameters which are available from the individual remote devices by device, including but not limited to all metered values, load status, alarm status, energy data, device position and/or status, device data logs, waveform capture, sag/swell events, etc.

- 4. Gather data via serial or ethernet links. Store historic and event data in a networked "SQL" database. Interface to third party hardware and software through Modbus RTU, Modbus TCP, OPC, SNMP, and XML.
- 5. Generate power quality, energy, load profile reports based on events or schedules. Standard and customized reports can be generated using an easy to use interface. The reports can be generated in a Microsoft Excel, HTML and PDF format and can be e-mailed, saved or printed out automatically.

PART 3: EXECUTION

3.01 INSTALLATION

- A. Comply with equipment installation requirements in NECA 1.
- B. Installation of Equipment BACnet Interface Devices
 - 1. See Responsibility Matrix for the execution responsibilities for Equipment Supplier, Controls and Electrical Subcontractor.
 - 2. Equipment Supplier is responsible for supplying and installing the BACnet Interface Device.
 - 3. Division 25 is responsible for communicating with the BACnet Interface Device using BACnet objects and services to access this data and for mapping the BACnet objects from the device(s) in this Specification Section to the BACnet Object Integration Device to create graphics, reports, trends, alarms, schedules and other requirements specified in Division 25. Division 25 is only responsible for communicating with the BACnet Interface Device using BACnet objects and services to access this data.
 - 4. Electrical is responsible for power and any control wiring if the device does not have a single point of connection.
 - 5. This BACnet Interface Device is a BACnet/IP device. See Division 27 for networking responsibilities.

3.02 FIELD QUALITY CONTROL

- A. Test Owner's electricity-metering installation for proper operation, accuracy, and usability of output data.
 - 1. Connect a load of known kilowatt rating, 1.5 kW minimum, to a circuit supplied by metered feeder.
 - 2. Turn off circuits supplied by metered feeder and secure them in off condition.
 - 3. Run test load continuously for eight hours, minimum, or longer to obtain a measurable meter indication. Use test load placement and setting that ensures continuous, safe operation.
 - 4. Check and record meter reading at end of test period and compare with actual electricity used based on test load rating, duration of test, and sample measurements of supply voltage at test load connection. Record test results.
 - 5. Repair or replace deficient or malfunctioning metering equipment, or correct test setup; then retest. Repeat for each meter in installation until proper operation of entire system is verified.

3.03 DEMONSTRATION, TRAINING AND COMMISSIONING

- A. Refer to Division 25 20 26.27.13 for BAS demonstration and training requirements.
- B. Equipment Supplier is responsible for commissioning all devices with Division 25. See 25 20 26.27.13 for details.
- C. Film training of systems as part of closeout documents. Refer to 01 79 00 Demonstration and Training for specific information.

END OF SECTION 26 27 13

SECTION 26 28 16

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1: GENERAL

1.01 SCOPE

A. This Section includes the furnishing and installation of all labor, materials, tools, appliances, hardware, junction boxes, and ancillary equipment for and incidental to the delivery, installation, and furnishing of completely operational enclosed switches and circuit breakers as shown, required, and specified herein.

1.02 RELATED SECTIONS

- A. Division 25 Section 25 20 26.28.16 Integrated Automation BACnet Interface Device (Gateways/Native BACnet Devices) Molded Case Circuit Breakers (All Types).
- B. 25 00 13 Integrated Automation General Requirements All Trades Work Responsibilities.
- C. Division 25 Schedule 3 BACNET SINGLE LINE DIAGRAM AND RESPONSIBILITY MATRIX (APPLIES TO ALL TRADES).

1.03 SUBMITTALS

- A. Shop Drawings shall be submitted for approval for all enclosed switches and circuit breakers as follows:
 - 1. Fusible switches.
 - 2. Non-fusible switches.
 - 3. Shunt trip switches.
 - 4. Molded-case circuit breakers (MCCBs).
 - 5. Molded-case switches.
 - 6. Enclosures.
- B. For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, details, wiring diagrams, attachments to other work, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.
 - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
 - 4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
 - 5. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.
 - 6. Include the BACnet Interface Device with Submittal showing proprietary points listed in 25 20 26.28.16 are mapped to BACnet Object Types. Failure to do so will result in automatic rejection of the submittal.
- C. Field quality-control reports.
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.04 CLOSEOUT SUBMITTALS

- A. Operation, Maintenance and Warranty Data: For enclosed switches and circuit breakers to include in emergency, operation, maintenance and warranty data manuals. In addition to items specified in Division 01 Section "Operation, Maintenance and Warranty Data," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

- 2. Test Data: Results of thermal scan tests.
- 3. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.05 QUALITY ASSURANCE

- A. Manufacturer of enclosed switches and circuit breakers shall be specialized in the manufacture and assembly of such equipment for a minimum of 25 years.
- B. Equipment shall be listed and/or classified by Underwriters Laboratories and in accordance with standards listed in this Specification.
- C. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 1.1 and trained in electrical safety as required by NFPA 70E.
- D. Testing Agency Qualifications: Member company of NETA or an NRTL.
 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- E. Source Limitations: Obtain enclosed switches and circuit breakers from single source from single manufacturer.

1.06 REFERENCES

- A. The products provided by this section shall comply with the following applicable references (latest edition):
 - 1. NEMA AB 1 Molded Case Circuit Breakers.
 - 2. NEMA KS 1 Enclosed Switches.
 - 3. NEMA PB 1 Panelboards.
 - 4. NEMA PB 1.1 Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600V or Less.
 - 5. UL 489 Molded Case Circuit Breakers.
 - 6. NFPA 70E Standard for Electrical Safety in the Workplace.
 - 7. NFPA 70 National Electrical Code

1.07 MAINTENANCE

- A. Manufacturer of enclosed switches and circuit breakers shall:
 - 1. Make ordering of new equipment for expansions, replacements, and spare parts available to end user.
 - 2. Make new replacement parts available for minimum of ten years from date of manufacture.
 - 3. Provide factory direct technical support hotline 24 hours per day, 7 days per week.
 - 4. Provide on-site service support within 24 hours anywhere in continental United States.
 - 5. Offer renewable service contract on yearly basis, to include parts, factory labor, and annual training visits. Make service contracts available up to ten years after date of system commissioning.

1.08 WARRANTY

A. The Contractor shall provide a <u>one-year warranty</u> of the installed system against defects in material and workmanship. All labor and materials shall be provided at no expense to the Owner. Warranty period shall begin on the date of acceptance as issued by the Architect's certificate of completion.

PART 2: PRODUCTS

2.01 GENERAL INFORMATION.

A. All electrical equipment and material shall be new and bear a recognized testing laboratory's label, where applicable. The type of equipment and/or material shall be designated by the location where it will be installed and so defined by NEMA / NFPA 70 standards.

2.02 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide enclosed switches by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Rockwell Automation; Allen-Bradley Co.; Industrial Control Group.
 - 5. Square D; a brand of Schneider Electric.

2.03 FUSIBLE / NON FUSIBLE SWITCH CONSTRUCTION AND RATINGS

- A. See drawings for number of poles, number of throw, voltage, current, AIC ratings, mounting, nameplates, environmental conditions, etc.
- B. General Fusible Switch Construction shall be:
 - 1. Type HD, Heavy Duty, Single Throw, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper neutral conductors.
 - 3. Class R Fuse Kit (if fusible): Provides rejection of other fuse types when Class R fuses are specified.
 - 4. Auxiliary Contact Kit (where indicated): One NO/NC (Form "C") auxiliary contact, arranged to activate before switch blades open.

2.04 MOLDED-CASE CIRCUIT BREAKERS

- A. See drawings for number of poles, voltage, current, AIC ratings, GFI or GFP, mounting, nameplates, environmental conditions, etc.
- B. General Molded-Case Circuit Breaker Construction shall be:
 - 1. Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
 - a. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. Adjustable, Instantaneous-Trip Circuit Breakers (where indicated): Magnetic trip element with front-mounted, field-adjustable trip setting.
 - 3. Electronic Trip Circuit Breakers (where indicated): Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I²t response.
 - 4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.
- C. Features and Accessories:
 - 1. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
 - 2. For breaker frame sizes 1200A and larger provide arc reduction maintenance switch function to meet NEC 240.87.

- 3. Equipment Ground Kit: Internally mounted and labeled for copper ground conductors.
- 4. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper neutral conductors.
- 5. Auxiliary Contact Kit (where indicated): One NO/NC (Form "C") auxiliary contact, arranged to activate before switch blades open.
- 6. BACnet Interface Devices
 - a. Provide BACnet Interface Devices for each Electronic Trip Unit so that the units are presented as a series of AV, BV and MSV BACnet objects. See 25 20 26.24.13 for the list of objects that must be supported. This list is the minimum acceptable.
 - b. If the Electronic Trip Units are not native BACnet/IP devices, supplier is responsible for providing a Modbus to BACnet gateway for the Electronic Trip Units supplied in the Work. Provide a Modbus RTU slave connection to each Electronic Trip Unit. Network all Electronic Trip Units together to the BACnet gateway. The basis of design product is the Real Time Automation Modbus to BACnet/IP gateway 460MX or approved equal. The BACnet/IP gateway shall come with embedded webserver capabilities for configuring the BACnet objects.

2.05 MOLDED-CASE SWITCHES

- A. See drawings for number of poles, voltage, AIC ratings, mounting, nameplates, environmental conditions, etc.
- B. General Molded-Case Switch Construction shall be:
 - 1. Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
 - 2. General Requirements: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.
- C. Features and Accessories:
 - 1. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
 - 2. Equipment Ground Kit: Internally mounted and labeled for copper ground conductors.
 - 3. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper neutral conductors.
 - 4. Auxiliary Contact Kit (where indicated): One NO/NC (Form "C") auxiliary contact, arranged to activate before switch blades open.

2.06 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
 - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 - 2. Outdoor Locations: NEMA 250, Type 3R.
 - 3. Kitchen, Wash-Down Areas: NEMA 250, Type 4X, Stainless Steel.
 - 4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
 - 5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
 - 6. Hazardous Areas Indicated on Drawings: NEMA 250, Type 9 (or as required by construction or indicated on drawings).

PART 3: EXECUTION

3.01 GENERAL INSTALLATION

A. Enclosed switches and circuit breakers shall be installed in a neat and workmanlike manner. The NEIS Standard Practices for Good Workmanship in Electrical Contracting NECA 1-2006 is hereby adopted to define such workmanship and the installation of conductors and cables.

- B. Provide all equipment, wiring, conduit, and junction boxes required for the installation of a complete and operating system in accordance with applicable local, state, and national codes, the manufacturers' recommendations, these plans and specifications.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Install fuses in fusible devices.

3.02 INSTALLATION OF BACNET INTERFACE DEVICES

- A. See Responsibility Matrix for the execution responsibilities for Equipment Supplier, Controls and Electrical Subcontractor."
- B. Equipment Supplier is responsible for supplying and installing the BACnet Interface Device.
- C. Electrical is responsible for power and any control wiring if the device does not have a single point of connection.
- D. Division 25 is responsible for communicating with the BACnet Interface Device using BACnet objects and services to access this data and for mapping the BACnet objects from the device(s) in this Specification Section to the BACnet Object Integration Device to create graphics, reports, trends, alarms, schedules and other requirements specified in Division 25. Division 25 is only responsible for communicating with the BACnet Interface Device using BACnet objects and services to access this data.
- E. This is a Modbus to BACnet/IP device. See Division 27 for networking responsibilities.Enclosed switches and circuit breakers shall be installed in a neat and workmanlike manner. The NEIS Standard Practices for Good Workmanship in Electrical Contracting NECA 1-2006 is hereby adopted to define such workmanship and the installation of conductors and cables.

3.03 EXAMINATION / COORDINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each enclosed switch / circuit breaker.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where enclosed switch / circuit breaker will be installed. Coordinate installation of wall-mounting and structure-hanging supports with actual enclosure provided. Coordinate layout and installation of enclosed switch / circuit breaker with other construction including conduit, piping, equipment, and adjacent surfaces.
- D. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met.
- E. Refer to Division 25 20 26.28.16 for BACnet Interface Device demonstration, commissioning and training requirements.

3.04 APPLICATIONS

- A. Select features of each enclosed switch / circuit breaker to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, controller, and load; and configuration of pilot device and control circuit affecting controller functions.
- B. Select horsepower rating of controllers to suit motor controlled.

3.05 IDENTIFICATION

- A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.06 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 3. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
 - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.07 ADJUSTING AND CLEANING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Upon completion of installation of panelboard, inspect interiors of enclosed switch / circuit breaker; clear all blockages and remove burrs, paint splatters and other spots, dirt, and construction debris. Touch up scratches and mars of finish to match original finish.
- C. Adjust Circuit Breaker trip and time-delay settings to values as instructed by the Architect/Engineer.

END OF SECTION 26 28 16

SECTION 26 32 13

ENGINE GENERATORS

PART 1: GENERAL

1.1 SCOPE

- A. This Section includes the furnishing of an electric generating set of the type and operating characteristics described hereinafter, completely installed, tested, and operative. All necessary equipment, labor, and materials shall be included; the coordination of all required equipment and material shall be the responsibility of one manufacturer, who has had an approved experience record in furnishing similar equipment. Capacity and voltage characteristics shall be as shown on the drawings. Contractor shall provide the required permits, generator modeling, and associated costs to install the new generator. The Registration Permit will require Dispersion Modeling using the EPA SCREEN 3 model.
- B. This Section includes a packaged engine-generator set for a Level 1 emergency power supply system with the following features:
 - 1. Diesel engines.
 - 2. Unit-mounted cooling system.
 - 3. Remote-mounted control and monitoring panel.
 - 4. Performance requirements for sensitive loads.
 - 5. Base mounted fuel oil tank.
 - 6. Outdoor enclosure.
 - 7. Maintenance platform.
- C. Concrete Bases:
 - 1. Equipment Mounting: Install generator on concrete base. Comply with requirements for concrete base specified in Division 03 Section. Concrete shall be 4,500 minimum PSI with synthetic microfiber reinforcement.
 - a. Coordinate size of equipment bases with actual unit sizes provided. Fabricate base 4 inches larger in both directions than the overall dimensions of the supported unit. Chamfer top edge and corners of pad.
 - b. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 - c. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - d. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - e. Install anchor bolts to elevations required for proper attachment to generator.

1.2 RELATED SECTIONS

- A. Division 25 Section 25 20 26.32.13 Integrated Automation BACnet Interface Device (Gateways/Native BACnet Devices) Engine Generators.
- B. 25 00 13 Integrated Automation General Requirements All Trades Work Responsibilities.
- C. Division 25 Schedule 3 BACNET SINGLE LINE DIAGRAM AND RESPONSIBILITY MATRIX (APPLIES TO ALL TRADES).

1.3 SUBMITTALS

- A. Shop Drawings shall be submitted for each type of packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Thermal damage curve for generator.
 - 3. Time-current characteristic curves for generator protective device.

- 4. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
- 5. Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
- 6. Vibration Isolation Base Details: Signed and sealed by a qualified professional engineer. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
- 7. Wiring Diagrams: Power, signal, and control wiring.
- 8. Include the BACnet Interface Device with Submittal showing proprietary points listed in 25 20 26.32.13 are mapped to BACnet Object Types. Failure to do so will result in automatic rejection of the submittal.
- B. Selective Coordination Study: Provide preliminary selective coordination study with shop submittal, indicating circuit breakers coordinate with critical and life safety distribution systems. Identify potential conflicts and provide suggested solutions.
- C. Qualification Data: For installer and manufacturer and testing agency.
- D. Source quality-control test reports.
 - 1. Certified summary of prototype-unit test report.
 - 2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
 - 3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
 - 4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements
 - 5. Report of sound generation.
 - 6. Report of exhaust emissions showing compliance with applicable regulations.
 - 7. Certified Torsional Vibration Compatibility: Comply with NFPA 110.
 - 8. Field Quality C
 - 9. Field quality-control test reports.
- E. Operation, Maintenance, and Warranty Data: For packaged engine generator to include in emergency, operation, maintenance, and warranty data manuals. In addition to items specified in Division 01 Section "Operation, Maintenance, and Warranty Data," include the following:
 - 1. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
- F. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

- A. Manufacturer of engine generators shall be specialized in the manufacture and assembly of such equipment for a minimum of 25 years.
- B. Equipment shall be listed and/or classified by Underwriters Laboratories and in accordance with standards listed in this Specification.
- C. Installer Qualifications:
 - 1. An employer of workers qualified as defined in NEMA PB 1.1 and trained in electrical safety as required by NFPA 70E.
 - 2. Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
 - 3. Maintenance Proximity: Not more than four hours' normal travel time from Installer's place of business to Project site.
 - 4. Engineering Responsibility: Preparation of data for vibration isolators and seismic restraints of engine skid mounts, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
- D. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 200 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.

- E. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.
- F. Comply with NFPA 37 and 70.
- G. Comply with NFPA 110 requirements for Level 1 emergency power supply system.
- H. Engine Exhaust Emissions: Comply with applicable state and local government requirements.
- I. Noise Emission: Comply with applicable state and local government requirements for maximum noise level due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.
- J. Comply with UL2200.

1.5 PROJECT CONDITIONS

- A. Restricted Space: Generator (including fuel tank and maintenance platform) shall fit within 21'-0" x 31'-0" CMU open enclosure (by General Contractor). Louvers will be provided by GC in walls at each end as required. Max generator assembly height of 14'-0". Coordinate door and louver locations with General Contractor.
- B. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
 - 1. Ambient Temperature: -20F to 100F.
 - 2. Altitude: Sea level to 1000 feet.
 - 3. Do not deliver or install interior engine-generator sets until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above engine-generators is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
- C. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving engine-generators into place.

1.6 REFERENCES

- A. The products provided by this section shall comply with the following applicable references (latest edition):
 - 1. ASME B15.1 Safety Standard for Mechanical Power Transmission.
 - 2. NFPA 37 Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines.
 - 3. NFPA 110 Standard for Emergency and Standby Power Systems.
 - 4. UL 2200 Stationary Engine Generator Assemblies

1.7 MAINTENANCE

- A. Engine generator manufacturer / vendor shall:
 - 1. Make ordering of new equipment for expansions, replacements, and spare parts available to end user.
 - 2. Make new replacement parts available for minimum of ten years from date of manufacture.
 - 3. Provide factory direct technical support hotline 24 hours per day, 7 days per week.
 - 4. Provide on-site service support within 24 hours anywhere in continental United States.
 - 5. Offer renewable service contract on yearly basis, to include parts, factory labor, and annual training visits. Make service contracts available up to ten years after date of system commissioning.
 - 6. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

1.8 COORDINATION

A. Coordinate size and location of concrete bases for package engine generators. Provide base thickness and size as recommended by generator supplier as a minimum or as indicated. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03. Coordinate layout and installation of generator with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 1 year from date of Substantial Completion.
 - 2. Provide to Owner, an optional extended warranty of (1), (2) and (3) years beyond 2 year warranty. Owner is <u>not</u> obligated to accept this extended warranty.

1.10 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

PART 2: PRODUCTS

2.1 GENERAL INFORMATION.

A. All electrical equipment and material shall be new and bear a recognized testing laboratory's label, where applicable. The type of equipment and/or material shall be designated by the location where it will be installed and so defined by NEMA / NFPA 70 standards.

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide complete generator set by one of the following:
 - 1. Caterpillar; Engine Div.
 - 2. Kohler Co.; Generator Division.
 - 3. Onan/Cummins Power Generation; Industrial Business Group.
 - 4. No equals.

2.3 ENGINE-GENERATOR SET

- A. Factory-assembled and -tested, engine-generator set. Vertical height shall be able to accommodate space indicated.
- B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.
 - 1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.
- C. Capacities and Characteristics:
 - 1. Power Output Ratings: Nominal ratings as indicated on drawings.
 - 2. Output Connections: Three-phase, four wire.
 - 3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

- D. Generator-Set Performance for Sensitive Loads:
 - 1. Oversizing generator compared with the rated power output of the engine is permissible to meet specified performance.
 - a. Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.
 - 2. Steady-State Voltage Operational Bandwidth: 1 percent of rated output voltage from no load to full load.
 - 3. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 0.5 second.
 - 4. Steady-State Frequency Operational Bandwidth: Plus or minus 0.25 percent of rated frequency from no load to full load.
 - 5. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
 - 6. Transient Frequency Performance: Less than 2-Hz variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three seconds.
 - 7. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2 percent total with no slot ripple. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
 - 8. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.
 - 9. Start Time: Comply with NFPA 110, Type 10, system requirements.
 - Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load.
 a. Provide permanent magnet excitation for power source to voltage regulator.

2.4 ENGINES

- A. Fuel: Fuel Oil, Grade DF-2.
- B. Rated Engine Speed: 1800 rpm.
- C. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm (11.4 m/s).
- D. Lubrication System: The following items are mounted on engine or skid:
 - 1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
 - 2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
 - 3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
- E. Engine Fuel System:
 - 1. Fuel: Fuel oil, Grade DF-2.
 - 2. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow starting and load conditions.
 - 3. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.
- F. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.
- G. Governor: Adjustable Isochronous, with speed sensing.
- H. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.
 - 1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer. Fill to -40 degrees F.
 - 2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
 - 3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.

- 4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
- 5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.
 - a. Rating: 50-psig (345-kPa) maximum working pressure with coolant at 180 deg F (82 deg C), and non-collapsible under vacuum.
 - b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.
- I. Muffler/Silencer: Critical silence type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
 - 1. Minimum sound attenuation of 18 dB at 500 Hz.
 - 2. Sound level measured at a distance of 10 feet from exhaust discharge after installation is complete shall be 70 dBA or less.
 - 3. Provide with stainless steel fittings, flanges, and flexible piping connected to exhaust.
- J. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.
- K. Starting System: 24V electric, with negative ground.
 - 1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
 - 2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
 - 3. Cranking Cycle: As required by NFPA 110 for system level specified. (10 seconds).
 - 4. Battery: Adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least three times without recharging.
 - 5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
 - 6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in Part 1 "Project Conditions" Article. Include accessories required to support and fasten batteries in place.
 - 7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
 - 8. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:
 - a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
 - b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
 - c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
 - d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
 - e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
 - f. Enclosure and Mounting: Weatherproof outdoor as indicated herein.

2.5 FUEL OIL STORAGE

A. Comply with NFPA 30.

- B. Day Tank: Comply with UL 142, freestanding, factory-fabricated fuel tank assembly, with integral, float-controlled transfer pump and the following features:
 - 1. Containment: Integral rupture basin with a capacity of 150 percent of nominal capacity of day tank.
 - a. Leak Detector: Locate in rupture basin and connect to provide audible and visual alarm in the event of day-tank leak.
 - 2. Tank Capacity: As recommended by engine manufacturer for an uninterrupted period of 72 hours' operation at 100 percent of rated power output of engine-generator system without being refilled. Fill to capacity on Project completion.
 - 3. Pump Capacity: Exceeds maximum flow of fuel drawn by engine-mounted fuel supply pump at 110 percent of rated capacity, including fuel returned from engine. Size to pump fuel from remote fuel oil storage tank located in same room. Refer to drawings.
 - 4. Low-Level Alarm Sensor: Liquid-level device operates alarm contacts at 25 percent of normal fuel level.
 - 5. High-Level Alarm Sensor: Liquid-level device operates alarm and redundant fuel shutoff contacts at midpoint between overflow level and 100 percent of normal fuel level.
 - 6. Piping Connections: Factory-installed fuel supply and return lines from tank to engine; local fuel fill, vent line, overflow line; and tank drain line with shutoff valve.
 - 7. Redundant High-Level Fuel Shutoff: Actuated by high-level alarm sensor in day tank to operate a separate motor device that disconnects day-tank pump motor. Sensor shall signal solenoid valve, located in fuel suction line between fuel storage tank and day tank, to close. Both actions shall remain in shutoff state until manually reset. Shutoff action shall initiate an alarm signal to control panel but shall not shut down engine-generator set.
 - 8. Provide an integral fuel meter and integrate the fuel meter reading into the BACnet Interface Device.
- C. Provide raised platform with access stairs as required to allow maintenance of unit.\
- D. Specification Section 25 20 26.32.13 includes the BACnet Interface Device requirements for an integrated belly tank.

2.6 UNIT MOUNTED CONTROL AND MONITORING PANELS

- A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one of more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched in the 'on' position, generator set starts. The 'off' position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.
- B. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common wall-mounted control and monitoring panel mounted.
 - 1. Wall-Mounted Cabinet Construction: Rigid-self-supporting steel unit complying with NEMA ICS6. Power bus shall be copper. Comply with UL 891.
- C. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 1 system, and the following:
 1. AC voltmeter.
 - 2. AC ammeter.
 - AC frequency meter.
 - 4. DC voltmeter (alternator battery charging).
 - 5. Engine-coolant temperature gage / timer.
 - 6. Engine lubricating-oil pressure gage.
 - 7. Running-time meter.
 - 8. Ammeter-voltmeter, phase-selector switch(es) with 'off' position.
 - 9. Generator-voltage adjusting rheostat.
 - 10. Generator overload.
 - 11. Crank cycle.
 - 12. Lamp test button(s)

- D. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated. Coordinate with automatic transfer switch requirements and include all power and control wiring in conduit between generators and transfer switches.
 - 1. Provide additional control wiring to load shed equipment automatic transfer switch(es) during generator overload.
- E. Connection to Data Link: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication is reserved for connections for data-link transmission of indications to remote data terminals. Data system connections to terminals are covered in Division 23 Section "Building Automation System." Provide conduit to BAS for monitoring purposes. Coordinate with Division 23 installers.
- F. Provide BACnet Interface Devices for each generator so that the units are presented as a series of AV, BV and MSV BACnet objects. See 25 20 26.32.13 for the list of objects that must be supported. This list is the minimum acceptable.
- G. Common Remote Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel.
 - 1. Overcrank shutdown.
 - 2. Coolant low-temperature alarm.
 - 3. Control switch not in auto position.
 - 4. Battery-charger malfunction alarm.
 - 5. Battery low-voltage alarm.
- H. Common Remote Audible Alarm: Signal the occurrence of any events listed below without differentiating between event types. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset.
 - 1. Engine high-temperature shutdown.
 - 2. Lube-oil, low-pressure shutdown.
 - 3. Over-speed shutdown.
 - 4. Remote emergency-stop shutdown.
 - 5. Engine high-temperature pre-alarm.
 - 6. Lube-oil, low-pressure pre-alarm.
 - 7. Low coolant level.
 - 8. Over-current alarm.
 - 9. Main Circuit Breaker in 'off' position.
 - 10. Ground Fault Alarm.
 - 11. Test switches and lamp tests.
- I. Remote Alarm Annunciator: Comply with NFPA 99. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated. Locate in per drawings.
 - 1. The equipment shall support both a remote annunciator and the Modbus to BACnet/IP BACnet Interface Device as simultaneous connections.
- J. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.
- K. Generator Control Wiring Integrity Provide continuous monitoring of generator control wiring. Loss of remote start signal for any below equipment shall initiate visual and audible annunciations of generator malfunction at the local and remote annunciator(s) and start the generator(s). Provide Asco 5101 Engine Start Circuit Monitor or equal. Provide all associated wiring.
 - 1. All Automatic Transfer Switches.

2.7 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. Generator Circuit Breakers: Molded-case, electronic-trip type(s); 100 percent rated; complying with UL 489.
 - 1. Tripping Characteristic: Designed specifically for generator protection.
 - 2. Trip Rating: Matched to generator rating.
 - 3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
 - 4. Mounting: Adjacent to or integrated with control and monitoring panel.
 - 5. Coordinated with Service Switchgear.
- B. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground-fault for units 1000A or more for 277/480V. Integrate ground-fault alarm indication with other generator-set alarm indications.
- C. Refer to drawings for generator location.

2.8 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

- A. Comply with NEMA MG 1.
- B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.
- C. Electrical Insulation: Class H or Class F.
- D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.
- E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
- F. Enclosure: Exterior weather-proof enclosure.
- G. Instrument Transformers: Mounted within generator enclosure (when not installed in control and power panel)..
- H. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.
 - 1. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of outputvoltage operating band.
- I. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.
- J. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
- K. Sub-transient Reactance: 12 percent, maximum.
- L. Refer to drawings for indicated generator voltage, KW/KVA load size, and output circuit breaker sizes specified.

2.9 OUTDOOR GENERATOR-SET ENCLOSURE

- A. Description: Vandal-resistant, weatherproof galvanized steel clad housing, wind resistant up to 100 mph, with heated, non-walk in enclosure, set on concrete foundation.
 - 1. Construction: Vandal-resistant, weatherproof, Galvanized –steel, clad, integral structural-steel-framed building erected on concrete foundation.
 - 2. Structural Design and Anchorage: Comply with ASCE 7 for wind loads at the installation location.
 - 3. Space Heater: Thermostatically controlled and sized to maintain a minimum space temperature of 45F.
 - 4. Hinged Doors: With padlocking provisions.
 - 5. Ventilation: Motorized Louvers equipped with bird screen and filter arranged to permit air circulation while excluding exterior dust, birds, and rodents. Thermostatically controlled.
 - 6. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine-generator-set components.
 - 7. Muffler Location: Within Enclosure.

- B. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.
 - 1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.
 - 2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.
- C. Interior AC Lights with Switch:Factory-wired, vaporproof-type fixtures within housing; with 30 foot candles average maintained on the controls and accessible interior. Connect to load center installed inside of enclosure.
- D. Convenience Outlets: Factory wired, GFCI. Connect to load center installed inside of enclosure.
- E. Load Center:
 - 1. Requirements:
 - a. Mounted inside the enclosure.
 - b. 120/128-10-3W.
 - c. Main Breaker.
 - d. Sized to serve the following loads:
 - 1) Lights and receptacles.
 - 2) Jacket heaters.
 - 3) Battery charger.
 - 4) Enclosure space heater.
 - 5) Battery blanket heater.
 - 6) Motorized louvers.
 - 2. Connect to feeder source inside the building as indicated on the Drawings.

2.10 VIBRATION ISOLATION DEVICES

- A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.
 - 1. Material: Standard neoprene.
 - 2. Durometer Rating: 30.
 - 3. Number of Layers: Two.
 - 4. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.
 - a. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch-thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
 - b. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
 - c. Minimum Additional Travel: 50 percent of required deflection at rated load.
 - d. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - e. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.11 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.12 SOURCE QUALITY CONTROL

- A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
 - 1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.

- B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
 - 1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
 - 2. Full load run.
 - 3. Maximum power.
 - 4. Voltage regulation.
 - 5. Transient and steady-state governing.
 - 6. Single-step load pickup.
 - 7. Safety shutdown.
 - 8. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
 - 9. Report factory test results within 10 days of completion of test.

PART 3: EXECUTION

3.1 GENERAL INSTALLATION

- A. Engine generators shall be installed in a neat and workmanlike manner. The NEIS Standard Practices for Good Workmanship in Electrical Contracting NECA 1-2006 is hereby adopted to define such workmanship and the installation of conductors and cables.
- B. Provide all equipment, wiring, conduit, and junction boxes required for the installation of a complete and operating system in accordance with applicable local, state, and national codes, the manufacturers' recommendations, these plans and specifications.

3.2 EXAMINATION

- A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.
- B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

- A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.
- B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.
- C. Install packaged engine generator with elastomeric isolator pads having a minimum deflection of 1 inch on 4-inch-(100-mm-) high concrete base. Secure sets to anchor bolts installed in concrete bases. Verify and provide structural support bars, and thickness and size of concrete base required by manufacturer of genset.
- D. Install Schedule 40, black steel piping with welded joints and connect to engine muffler. Install thimble at wall or ceiling. Size exhaust vent per manufacturer's isntructions. Provide flexible connectors and steel piping materials and installation requirements to meet as specified in Division 23 Section "Hydronic Piping."
 - 1. Install condensate drain piping to muffler drain outlet full size of drain connection with a shutoff valve, stainlesssteel flexible connector, and Schedule 40, black steel pipe with welded joints.
- E. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted. Provide all interconnection and control wiring in conduit between genset and all automatic transfer switches and remote alarm, control and/or monitoring and annunciator panels. Verify wire quantities and types with manufacturer(s) of alarm or monitoring panels.

- F. Connect generator dampers, fuel pump motors and associated electrically operated items on emergency power circuits where required for generator operation.
- G. Provide full tank of fuel after acceptance by Owner/Engineer/Commissioning Agent.
- H. Installation of Equipment BACnet Interface Devices
 - 1. See Responsibility Matrix for the execution responsibilities for Equipment Supplier, Controls and Electrical Subcontractor.
 - 2. Equipment Supplier is responsible for supplying and installing the BACnet Interface Device.
 - 3. Division 25 is responsible for communicating with the BACnet Interface Device using BACnet objects and services to access this data and for mapping the BACnet objects from the device(s) in this Specification Section to the BACnet Object Integration Device to create graphics, reports, trends, alarms, schedules and other requirements specified in Division 25. Division 25 is only responsible for communicating with the BACnet Interface Device using BACnet objects and services to access this data.
 - 4. Electrical is responsible for power and any control wiring if the device does not have a single point of connection.
 - 5. This BACnet Interface Device is a BACnet/IP device. See Division 27 for networking responsibilities.

3.4 CONNECTIONS

- A. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.
- B. Connect engine exhaust pipe to engine with flexible connector.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.5 IDENTIFICATION

A. Identify system components according to Division 26 Section "Identification for Electrical Systems."

3.6 FIELD QUALITY CONTROL

- A. Notify commissioning agent in advance of performing tests and inspections.
- B. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 - 1. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection for "AC Generators and for Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.
 - a. Tests shall be witnessed by Commissioning Agent.
 - b. Testing shall include demonstration of all operational requirements, including open and closed transition switching as applicable at light (quarter-load), medium (half-load) and full load. Testing shall also include four consecutive hours of operation at full load.
 - 3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
 - a. Measure charging voltage and voltages between available battery terminals for full-charging and floatcharging conditions. Check electrolyte level and specific gravity under both conditions.
 - b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.Verify acceptance of charge for each element of the battery after discharge.
 - c. Verify that measurements are within manufacturer's specifications.
 - 4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.

- 5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
- 6. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
- 7. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.
- D. Coordinate tests with tests for transfer switches and run them concurrently.
- E. Test instruments shall have been calibrated within the last 12 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.
- F. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
- G. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
- H. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- I. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.
- J. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.
- K. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each power wiring termination and each bus connection. Remove all access panels so terminations and connections are accessible to portable scanner.
 - 1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan 11 months after date of Substantial Completion.
 - 2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 3. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- L. Include all testing reports in Operation, Maintenance, and Warranty Data Manual(s).

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators. Provide video taping of this session. Refer to Division 01 Section "Demonstration and Training." Provide an 8 hour training session for Owner personnel.
- B. Refer to Division 25 20 26.32.13 for BACnet Interface Device commissioning, demonstration and training requirements.
- C. Film training of systems as part of closeout documents. Refer to 01 79 00 Demonstration and Training for specific information.

END OF SECTION 26 32 13

SECTION 26 33 53

STATIC UNINTERRUPTIBLE POWER SUPPLY

PART 1: GENERAL

1.01 SUMMARY

- A. This Section includes 480V-in, 480V-out, three-phase, on-line, double-conversion, static-type, UPS installations complete with transient voltage surge suppression, input harmonics reduction, rectifier-charger, lithium ion batteries, battery disconnect device, inverter, static bypass transfer switch, external maintenance bypass/isolation switch, output circuit breaker, emergency power off switch, remote UPS monitoring provisions and network interface card to coordinate safe-shutdown of servers.
- B. Battery life shall be base bid 33 minutes, Alternate #1 (deduct) bid 21 minutes.

1.02 RELATED SECTIONS

- A. 25 20 26.33.53 Integrated Automation BACnet Interface Device (Gateways/Native BACnet Devices) Uninterruptible Power Supply (All Types).
- B. 25 00 13 Integrated Automation General Requirements All Trades Work Responsibilities.
- C. Division 25 Schedule 3 BACNET SINGLE LINE DIAGRAM AND RESPONSIBILITY MATRIX (APPLIES TO ALL TRADES).

1.03 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. LCD: Liquid-crystal display.
- C. LED: Light-emitting diode.
- D. THD: Total harmonic distortion.
- E. UPS: Uninterruptible power supply.

1.04 SUBMITTALS

- A. Product Data: Include data on features, components, ratings, and performance for each UPS component indicated.
- B. Shop Drawings: Detail assemblies of equipment indicating dimensions, weights, components, and location and identification of each field connection. Show access, workspace, and clearance requirements; details of control panels; and battery arrangement.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Qualification Data: For Installer and manufacturer.
- D. Manufacturer Certificates: For each product, signed by manufacturers.
- E. Factory Test Reports: Comply with specified requirements.
- F. Field Quality-Control and Performance Test Reports: Indicate test results compared with specified performance requirements, and provide justification and resolution of differences if values do not agree.
- G. Operation and Maintenance Data: For UPS units to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 1. Lists of spare parts and replacement components recommended being stored at Project site for ready access.

- 2. Detailed operating instructions covering operation under both normal and abnormal conditions.
- H. Include the BACnet Interface Device with Submittal showing proprietary points listed in 25 20 26.33.53 are mapped to BACnet Object Types. Failure to do so will result in automatic rejection of the submittal.
- I. Warranties: Special warranties specified in this Section.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for both installation and maintenance of units required for this Project.
- B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 200 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs with four hours' maximum response time.
- C. Source Limitations: Obtain the UPS and associated components specified in this Section from a single manufacturer with responsibility for entire UPS installation.
- D. 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.
- E. UL Compliance: Listed and labeled under UL 1778.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver equipment in fully enclosed vehicles after specified environmental conditions have been permanently established in spaces where equipment is to be placed.
- B. Store equipment in spaces with environments controlled within manufacturer's ambient temperature and humidity tolerances for non-operating equipment.

1.07 WARRANTY

- A. Coordinate ship date and testing/startup of equipment with project substantial completion schedule.
- B. Special Battery Warranties: Specified form in which manufacturer and Installer agree to repair or replace UPS system storage batteries that fail in materials or workmanship within specified warranty period.
 - 1. The UPS manufacturer shall pass on to owner the battery manufactures standard warranty. At a minimum, the required standard battery warranty shall be a 10 year full parts warranty from date of manufacturing.
- C. Special UPS Warranties: Specified form in which manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within special warranty period.
 - 1. Special Warranty Period: Two years from date of Substantial Completion.

1.08 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials to Owner.
 - 1. Fuses: One for every 10 of each type and rating, but no fewer than 1 of each.
 - 2. Cabinet Ventilation Filters: One complete set.

PART 2: PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide Liebert 480V EXM (basis of design) or approved equal.
 - 1. Liebert EXM, a division of Vertiv (basis of design)
 - 2. APC: a Schneider Company.

- 3. Powerware; an Eaton Company.
- 4. Toshiba International Corporation.

2.02 PERFORMANCE DESCRIPTION

- A. General:
 - 1. The UPS shall be sized with output as indicated on riser drawings (unity load power factor rating).
 - 2. The UPS shall be able to supply all required power to full rated output kVA loads with power factor from 0.5 lagging to 0.9 leading. The UPS shall also work from unity power factor to 0.5 leading power factors subject to derating.
 - 3. Load voltage and bypass line voltage shall be 480VAC, three-phase, four-wire plus ground. Input voltage shall be 480VAC, three-phase, four-wire plus ground. The AC input source and bypass input source shall each be a solidly grounded wye service.
 - 4. The battery shall support the UPS at 100% rated kW load for the specified runtime minutes at 77°F at startup.
 - 5. The UPS shall be of transformer-free design, requiring no internal transformer in the main power path for the basic operation of the module. Optional transformers in cabinets or otherwise external to the basic UPS module shall be permissible to provide isolation and/or voltage transformation.
- B. Automatic operation includes the following:
 - 1. Normal Conditions: Supply the load with ac power flowing from the normal ac power input terminals, through the rectifier-charger and inverter, with the battery connected in parallel with the rectifier-charger output.
 - 2. Abnormal Supply Conditions: If normal ac supply deviates from specified and adjustable voltage, voltage waveform, or frequency limits, the battery supplies energy to maintain constant, regulated inverter ac power output to the load without switching or disturbance.
 - 3. If normal power fails, energy supplied by the battery through the inverter continues supply-regulated ac power to the load without switching or disturbance.
 - 4. When power is restored at the normal supply terminals of the system, controls automatically synchronize the inverter with the external source before transferring the load. The rectifier-charger then supplies power to the load through the inverter and simultaneously recharges the battery.
 - 5. If the battery becomes discharged and normal supply is available, the rectifier-charger charges the battery. On reaching full charge, the rectifier-charger automatically shifts to float-charge mode.
 - 6. If any element of the UPS system fails and power is available at the normal supply terminals of the system, the static bypass transfer switch switches the load to the normal ac supply circuit without disturbance or interruption.
 - 7. If a fault occurs in the system supplied by the UPS, and current flows in excess of the overload rating of the UPS system, the static bypass transfer switch operates to bypass the fault current to the normal ac supply circuit for fault clearing.
 - 8. When the fault has cleared, the static bypass transfer switch returns the load to the UPS system.
 - 9. If the battery is disconnected, the UPS continues to supply power to the load with no degradation of its regulation of voltage and frequency of the output bus.
- C. Manual operation includes the following:
 - 1. Full Isolation: Load is supplied, bypassing the UPS. Normal UPS ac input circuit, static bypass transfer switch are completely disconnected from external circuits.
 - 2. Maintenance Bypass: Load is supplied, bypassing the UPS. UPS ac supply terminals are energized to permit operational checking, but system load terminals are isolated from the load.
 - 3. Normal: Normal UPS ac supply terminals are energized and the load is supplied through the UPS rectifiercharger and inverter, or the battery and the inverter.

2.03 SERVICE CONDITIONS

- A. Environmental Conditions: The UPS shall be capable of operating continuously in the following environmental conditions without mechanical or electrical damage or degradation of operating capability, except battery performance.
 - 1. Ambient Temperature for Electronic Components: 32 to 104 deg F.
 - 2. Ambient Temperature for Battery: 41 to 95 deg F.

- 3. Relative Humidity: 0 to 95 percent, noncondensing.
- 4. Altitude: Sea level to 4000 feet.

2.04 PERFORMANCE REQUIREMENTS

- A. The UPS shall perform as specified in this Article while supplying rated full-load current, composed of any combination of linear and nonlinear load, up to 100 percent nonlinear load with a load crest factor of 3.0, under the following conditions or combinations of the following conditions:
 - 1. Inverter is switched to battery source.
 - 2. Steady-state ac input voltage deviates up to plus or minus 10 percent from nominal voltage.
 - 3. Steady-state input frequency deviates up to plus or minus 5 percent from nominal frequency.
 - 4. THD of input voltage is 15 percent or more with a minimum crest factor of 3.0, and the largest single harmonic component is a minimum of 5 percent of the fundamental value.
 - 5. Load is 100 percent unbalanced continuously.
- B. Minimum Duration of Supply: If battery is sole energy source supplying rated full UPS load current, duration of supply is:
 - 1. Base bid: 33 minutes.
 - 2. Alternate #1 (deduct) bid: 21 minutes.
- C. Input Voltage Tolerance: System steady-state and transient output performance remains within specified tolerances when steady-state ac input voltage varies plus 10, minus 15 percent from nominal voltage.
- D. Overall UPS Efficiency: Equal to or greater than 95 percent at 100 percent load, 95 percent at 75 percent load, and 95 percent at 50 percent load.
- E. Maximum Acoustical Noise: 63.2 dbA, emanating from any UPS component under any condition of normal operation, measured 54 inches from nearest surface of component enclosure.
- F. Maximum Energizing Inrush Current: 1.5 times the full-load current.
- G. Maximum AC Output-Voltage Regulation for Loads up to 50 Percent Unbalanced: Plus or minus 2 percent over the full range of battery voltage.
- H. Output Frequency: 60 Hz, plus or minus 0.5 percent over the full range of input voltage, load, and battery voltage.
- I. Limitation of harmonic distortion of input current to the UPS shall be as follows:
 - 1. Description: Either a tuned harmonic filter or an arrangement of rectifier-charger circuits shall limit THD to 5 percent, maximum, at rated full UPS load current, for power sources with X/R ratio between 2 and 30.
- J. Maximum Harmonic Content of Output-Voltage Waveform: 5 percent RMS total and 3 percent RMS for any single harmonic, for 100 percent rated nonlinear load current with a load crest factor of 3.0.
- K. Minimum Overload Capacity of UPS at Rated Voltage: 125 percent of rated full load for 10 minutes, and 150 percent for 60 seconds in all operating modes.
- L. Maximum Output-Voltage Transient Excursions from Rated Value: For the following instantaneous load changes, stated as percentages of rated full UPS load, voltage shall remain within stated percentages of rated value and recover to, and remain within, plus or minus 2 percent of that value within 100 ms:
 - 1. 50 Percent: Plus or minus 5 percent.
 - 2. 100 Percent: Plus or minus 5 percent.
 - 3. Loss of AC Input Power: Plus or minus 1 percent.
 - 4. Restoration of AC Input Power: Plus or minus 1 percent.
- M. Input Power Factor: A minimum of 0.85 lagging when supply voltage and current are at nominal rated values and the UPS is supplying rated full-load current.
- N. EMI Emissions: Comply with FCC Rules and Regulations, and with 47 CFR 15 for Class A equipment.

2.05 UPS SYSTEMS

- A. Electronic Equipment: Solid-state devices using hermetically sealed, semiconductor elements. Devices include rectifier-charger, inverter, static bypass transfer switch, and system controls.
- B. Enclosures: Comply with NEMA 250, Type 1, unless otherwise indicated.
- C. Control Assemblies: Mount on modular plug-ins, readily accessible for maintenance.
- D. Surge Suppression: Protect internal UPS components from surges that enter at each ac power input connection including main disconnect switch, static bypass transfer switch, and maintenance bypass/isolation switch. Protect rectifier-charger, inverter, controls, and output components.
 - 1. Use factory-installed surge suppressors tested according to IEEE C62.41, Category B.
 - 2. Additional Surge Protection: Protect internal UPS components from low-frequency, high-energy voltage surges described in IEEE C62.41. Design the circuits connecting with external power sources and select circuit elements, conductors, conventional surge suppressors, and rectifier components and controls so input assemblies will have adequate mechanical strength and thermal and current-carrying capacity to withstand stresses imposed by 40-Hz, 180 percent voltage surges described in IEEE C62.41.
- E. Maintainability Features: Mount rectifier-charger and inverter sections and the static bypass transfer switch on modular plug-ins, readily accessible for maintenance.
- F. Capacity Upgrade Capability: Arrange wiring, controls, and modular component plug-in provisions to permit future increase in UPS capacity to 100kVA without additional cabinets or expanding system footprint.
- G. Output Circuit Neutral Bus, Conductor, and Terminal Ampacity: Rated phase current times a multiple of 1.73, minimum.

2.06 RECTIFIER-CHARGER

- A. Capacity: Adequate to supply the inverter during rated full output load conditions and simultaneously recharge the battery from fully discharged condition to 95 percent of full charge within 10 times the rated discharge time for duration of supply under battery power at full load.
- B. Output Ripple: Limited by output filtration to less than 0.5 percent of rated current, peak to peak.
- C. Rectifier-Charger Control Circuits: Immune to frequency variations within rated frequency ranges of normal and emergency power sources.
 - 1. Response Time: Field adjustable for maximum compatibility with local generator-set power source.
- D. Battery Float-Charging Conditions: Comply with battery manufacturer's written instructions for battery terminal voltage and charging current required for maximum battery life.

2.07 INVERTER

A. Description: Pulse-width modulated, with sinusoidal output. Include a bypass phase synchronization window adjustment to optimize compatibility with local engine-generator-set power source.

2.08 STATIC BYPASS TRANSFER SWITCH

- A. Description: Solid-state switching device providing uninterrupted transfer. A contactor or electrically operated circuit breaker automatically provides electrical isolation for the switch.
- B. Switch Rating: Continuous duty at the rated full UPS load current, minimum.

2.09 BATTERY

- A. Description: Lithium-ion battery units, factory assembled in an isolated compartment or in a separate matching cabinet, complete with battery disconnect switch.
 - 1. Arrange for drawout removal of battery assembly from cabinet for testing and inspecting.

- 2. Manufacturers:
 - a. Samsung
 - b. Vertiv HPL
 - c. Toshiba SCIB
 - d. Or equal

2.10 CONTROLS AND INDICATIONS

- A. Description: Group displays, indications, and basic system controls on a common control panel on front of UPS enclosure.
- B. Provide remote annunciator panel located at dispatch manager's station. Recess in wall. Include visual and audible indication of UPS state and battery time remaining, with one-touch ability to silence audible alarm.
- C. Minimum displays, indicating devices, and controls include those in lists below. Provide sensors, transducers, terminals, relays, and wiring required to support listed items. Alarms include audible signals and visual displays.
- D. Include a communication card to provide web-based UPS monitoring and management capabilities and one or two of the following remote monitoring protocols: SNMP (v1, v2, v3), Modbus or BACnet for remote monitoring.
- E. Include a network interface card to communicate via the network with servers and other equipment to orchestrate a coordinated safe-shutdown of server equipment in the event of an extended power outage.
- F. Indications: LCD touchscreen HMI

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- Quantitative indications shall include the following:
- a. Input voltage, each phase, line to line.
- b. Input current, each phase, line to line.
- c. Bypass input voltage, each phase, line to line.
- d. Bypass input frequency.
- e. System output voltage, each phase, line to line.
- f. System output current, each phase.
- g. System output frequency.
- h. DC bus voltage.
- i. Battery current and direction (charge/discharge).
- j. Elapsed time discharging battery.
- 2. Basic status condition indications shall include the following:
 - a. Normal operation.
 - b. Load-on bypass.
 - c. Load-on battery.
 - d. Inverter off.
 - e. Alarm condition.
- 3. Alarm indications shall include the following:
 - a. Bypass ac input overvoltage or undervoltage.
 - b. Bypass ac input overfrequency or underfrequency.
 - c. Bypass ac input and inverter out of synchronization.
 - d. Bypass ac input wrong-phase rotation.
 - e. Bypass ac input single-phase condition.
 - f. Bypass ac input filter fuse blown.
 - g. Internal frequency standard in use.
 - h. Battery system alarm.
 - i. Control power failure.
 - j. Fan failure.
 - k. UPS overload.
 - l. Battery-charging control faulty.
 - m. Input overvoltage or undervoltage.
 - n. Input transformer overtemperature.
 - o. Input circuit breaker tripped.
 - p. Input wrong-phase rotation.

- q. Input single-phase condition.
- r. Approaching end of battery operation.
- s. Battery undervoltage shutdown.
- t. Maximum battery voltage.
- u. Inverter fuse blown.
- v. Inverter transformer overtemperature.
- w. Inverter overtemperature.
- x. Static bypass transfer switch overtemperature.
- y. Inverter power supply fault.
- z. Inverter transistors out of saturation.
- aa. Identification of faulty inverter section/leg.
- bb. Inverter output overvoltage or undervoltage.
- cc. UPS overload shutdown.
- dd. Inverter current sensor fault.
- ee. Inverter output contactor open.
- ff. Inverter current limit.
- Controls shall include the following:
- a. Inverter on-off.
- b. UPS start.
- c. Battery test.
- d. Alarm silence/reset.
- e. Output-voltage adjustment.
- G. Dry-form "C" contacts shall be available for remote indication of the following conditions:
 - 1. UPS on battery.
 - 2. UPS on-line.

4.

- 3. UPS load-on bypass.
- 4. UPS in alarm condition.
- 5. UPS off (maintenance bypass closed).
- H. Emergency Power Off Switch:
 - 1. Capable of local operation and operation by means of activation by external dry contacts.
 - 2. Locking type and protected by a safety cover.
 - 3. Interconnect with server room clean agent system so as to automatically deactivate UPS power prior to clean agent discharge.
- I. Provide BACnet Interface Devices for each Uninterruptible Power Supply Unit so that the units are presented as a series of AV, BV and MSV BACnet objects. See 25 20 26.33.53 for the list of objects that must be supported. This list is the minimum acceptable.

2.11 MAINTENANCE BYPASS/ISOLATION SWITCH

- A. Description: Manually operated switch or arrangement of switching devices with mechanically actuated contact mechanism arranged to route the flow of power to the load around the rectifier-charger, inverter, and static bypass transfer switch.
 - 1. Switch shall be electrically and mechanically interlocked to prevent interrupting power to the load when switching to bypass mode.
 - 2. Switch shall electrically isolate other UPS components to permit safe servicing.
- B. Switch Rating: Continuous duty at rated full UPS load current.
- C. Mounting Provisions: Separate wall- or floor-mounted unit attached to UPS cabinet with interconnect cables for power and control provided by UPS manufacture for connection to UPS
- D. Key interlock requires unlocking maintenance bypass/isolation switch before switching from normal position with key that is released only when the UPS is bypassed by the static bypass transfer switch. Lock is designed specifically for mechanical and electrical component interlocking.

2.12 EMERGENCY POWER OFF (EPO) SWITCH

- A. Provide EPO switch near the exit of the room housing the UPS. The button shall be located per NEC requirements, near the door at eye level but in a location that will not be subject to inadvertent contact. The button shall be provided with a shield to prevent accidental actuation from inadvertent contact.
- B. When the EPO button is pressed, power to room panels shall be shut off via shunt trip breaker. Additionally the UPS shall shut off power to equipment it serves.
- C. Provide a permanent, wall-mounted plaque near the EPO with instructions for restarting the power following an EPO event. Plaque shall be fabricated from engraved plastic or a similar indelible material. Text on the plaque shall be as follows:
 - 1. Before resetting any EPO pushbutton, verify that:
 - a. The condition for which EPO activation occurred has been corrected.
 - b. Fire suppression systems have been reset to clear alarms.
 - 2. Reset the activated EPO Station.
 - 3. Verify that all loads are fully energized and reset. Shunt any tripped breakers.
 - 4. If cooling units are not working, consult manufacturer's startup procedures.
- D. Description: Solid-state switching device providing uninterrupted transfer. A contactor or electrically operated circuit breaker automatically provides electrical isolation for the switch.
- E. Switch Rating: Continuous duty at the rated full UPS load current, minimum.

2.13 BASIC BATTERY MONITORING

- A. The battering monitoring system shall perform the below automatic functions. This self-test system shall signal faults via LED's on the front panel or a message to remote supervision systems.:
 - 1. Battery circuit checks every twelve hours.
 - 2. Open-circuit battery test once a month.
 - 3. Partial discharge test every three months.
- B. Annunciation of Alarms: At UPS control panel.

2.14 SOURCE QUALITY CONTROL

- A. Factory test complete UPS system before shipment. Use simulated battery testing. Include the following:
 - 1. Test and demonstration of all functions, controls, indicators, sensors, and protective devices.
 - 2. Full-load test.
 - 3. Transient-load response test.
 - 4. Overload test.
 - 5. Power failure test.
- B. Report test results. Include the following data:
 - 1. Description of input source and output loads used. Describe actions required to simulate source load variation and various operating conditions and malfunctions.
 - 2. List of indications, parameter values, and system responses considered satisfactory for each test action. Include tabulation of actual observations during test.
 - 3. List of instruments and equipment used in factory tests.

PART 3: EXECUTION

3.01 INSTALLATION

A. Install system components on 4-inch- high concrete bases. Concrete base construction requirements are specified in Division 26 Section "Hangers and Supports for Electrical Systems."

- B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.
- C. Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams, unless otherwise indicated.
- D. Installation of Equipment BACnet Interface Devices
 - 1. See Responsibility Matrix for the execution responsibilities for Equipment Supplier, Controls and Electrical Subcontractor.
 - 2. Equipment Supplier is responsible for supplying and installing the BACnet Interface Device.
 - 3. Division 25 is responsible for communicating with the BACnet Interface Device using BACnet objects and services to access this data and for mapping the BACnet objects from the device(s) in this Specification Section to the BACnet Object Integration Device to create graphics, reports, trends, alarms, schedules and other requirements specified in Division 25. Division 25 is only responsible for communicating with the BACnet Interface Device using BACnet objects and services to access this data.
 - 4. Electrical is responsible for power and any control wiring if the device does not have a single point of connection.
 - 5. This BACnet Interface Device is a BACnet/IP device. See Division 27 for networking responsibilities.

3.02 GROUNDING

A. Separately Derived Systems: If not part of a listed power supply for a data-processing room, comply with NFPA 70 requirements for connecting to grounding electrodes and for bonding to metallic piping near isolation transformer.

3.03 IDENTIFICATION

A. Identify components and wiring according to Division 26 Section "Identification for Electrical Systems."

3.04 FIELD QUALITY CONTROL

- A. Electrical Tests and Inspections: Perform tests and inspections according to manufacturer's written instructions and as listed below to demonstrate condition and performance of each UPS component:
 - 1. Inspect interiors of enclosures, including the following:
 - a. Integrity of mechanical and electrical connections.
 - b. Component type and labeling verification.
 - c. Ratings of installed components.
 - 2. Test manual and automatic operational features and system protective and alarm functions.
 - 3. Test communication of status and alarms to remote monitoring equipment.
- B. Retest: Correct deficiencies and retest until specified requirements are met.
- C. Record of Tests and Inspections: Maintain and submit documentation of tests and inspections, including references to manufacturers' written instructions and other test and inspection criteria. Include results of tests, inspections, and retests.

3.05 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the UPS. Refer to Division 01 Section "Demonstration and Training."
- B. Refer to Division 25 20 26.33.53 for BACnet Interface Device commissioning, demonstration and training requirements.
- C. Film training of systems as part of closeout documents. Refer to 01 79 00 Demonstration and Training for specific information.

3.06 PERFORMANCE TESTING

A. Notify commissioning agent in advance of performing tests and inspections.

- B. Engage the services of a qualified power quality specialist to perform tests and activities indicated below for each UPS system.
- C. Monitoring and Testing Schedule:
 - 1. Perform monitoring and testing in a single 8 hour period.
 - 2. Coordinate testing with generator.
 - 3. Schedule monitoring and testing activity with Owner, through Architect, with at least 14 days' advance notice.
- D. Monitoring and Testing Procedure:
 - 1. Test for correct output voltage prior to connecting Owner's electronic equipment.
 - 2. Exploratory Period: For approximately the first two hours make recordings at various circuit locations and with various parameter-threshold and sampling-interval settings. Make these preliminary measurements with the objective of identifying optimum UPS, power system, load, and instrumentation set-up conditions for subsequent test and monitoring operations.
 - 3. Remainder of Test Period: Perform continuous monitoring of at least two circuit locations selected on the basis of data obtained during exploratory period.
 - a. Set thresholds and sampling intervals for recording data at values selected to optimize data on performance of the UPS with respect to values specified in Part 2, and to highlight any need to adjust, repair, or modify the UPS.
 - b. Operate the UPS and its loads in each mode of operation permitted by UPS controls and by the power distribution system design.
- E. Documentation: Record test point and sensor locations, instrument settings, and circuit and load conditions for each monitoring summary and power disturbance recording. Coordinate simultaneous recordings made on UPS input and load circuits.
- F. Analysis of Recorded Data and Report: Review and analyze test observations and recorded data and submit a detailed written report. Include the following in final report.
 - 1. Description of corrective actions performed during monitoring and survey work and their results.
 - 2. Recommendations for further action to provide optimum performance by the UPS and appropriate power quality for non-UPS loads.
 - 3. Copies of monitoring summary graphics and graphics illustrating harmonic content of significant voltages and currents.
 - 4. Copies of graphics of power disturbance recordings that illustrate findings, conclusions, and recommendations.
 - 5. Recommendations for operating, adjusting, or revising UPS controls.
 - 6. Recommendation for alterations to the UPS installation.

END OF SECTION 26 33 53

SECTION 26 33 56 EMERGENCY LIGHTING INVERTER

PART 1: GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Emergency lighting inverter to provide 120 minutes of backup power to storm shelter lighting and motorized louver loads.

1.02 RELATED SECTIONS

- A. 25 20 26.33.56 Integrated Automation BACnet Interface Device (Gateways / Native BACnet Devices) Emergency Lighting Inverters (All Types).
- B. 25 00 13 Integrated Automation General Requirements All Trades Work Responsibilities.
- C. Division 25 Schedule 3 BACNET SINGLE LINE DIAGRAM AND RESPONSIBILITY MATRIX (APPLIES TO ALL TRADES).

1.03 SUBMITTALS

- A. Product Data: Include data on features, components, ratings, and performance for each inverter component indicated.
- B. Shop Drawings: Detail assemblies of equipment indicating dimensions, weights, components, and location and identification of each field connection. Show access, workspace, and clearance requirements; details of control panels; and battery arrangement.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Qualification Data: For Installer and manufacturer.
- D. Manufacturer Certificates: For each product, signed by manufacturers.
- E. Factory Test Reports: Comply with specified requirements.
- F. Field Quality-Control and Performance Test Reports: Indicate test results compared with specified performance requirements, and provide justification and resolution of differences if values do not agree.
- G. Operation and Maintenance Data: For UPS units to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Lists of spare parts and replacement components recommended being stored at Project site for ready access.
 - 2. Detailed operating instructions covering operation under both normal and abnormal conditions.
- H. Include the BACnet Interface Device with Submittal showing proprietary points listed in 25 20 26.33.56 are mapped to BACnet Object Types. Failure to do so will result in automatic rejection of the submittal.
- I. Warranties: Special warranties specified in this Section.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for both installation and maintenance of units required for this Project.
- B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 200 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs with four hours' maximum response time.

- C. Source Limitations: Obtain the inverter and associated components specified in this Section from a single manufacturer with responsibility for entire inverter installation.
- D. 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.
- E. UL Compliance: Listed and labeled under UL 924.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver equipment in fully enclosed vehicles after specified environmental conditions have been permanently established in spaces where equipment is to be placed.
- B. Store equipment in spaces with environments controlled within manufacturer's ambient temperature and humidity tolerances for non-operating equipment.

PART 2: PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Myers Emergency Power Systems 7-EM-4-S-BD2004/BA2006-BIP-F-120MIN
 - 2. Sure-Lites
 - 3. Toshiba
 - 4. Core Power
 - 5. Evenlite

2.02 PERFORMANCE DESCRIPTION

- A. Technical:
 - 1. Input Voltage: 277V single phase 2-wire plus ground.
 - 2. Short circuit rating: 65 kAIC.
 - 3. Output Voltage and Breakers:
 - a. Normally on.
 - b. 277V: (4) 20A/1P breakers.
 - c. 120V: (6) 20A/1P breakers.
 - 4. Size:
 - a. Calculated load: 1.8kW.
 - b. Nameplate: 2.8 kW.
 - 5. Batteries:
 - a. Valve-regulated lead acid.
 - b. 120 minutes at calculated load (required for storm shelter).
 - 6. BACnet IP for monitoring by BAS. Provide BACnet Interface Devices for each Emergency Lighting Inverter so that the units are presented as a series of AV, BV and MSV BACnet objects. See 25 20 26.33.56 for the list of objects that must be supported. This list is the minimum acceptable.
- B. Standard Features:
 - 1. 98% efficiency.
 - 2. Output load power factor: 0.5 lag to 0.5 lead.
 - 3. Output distortion less than 3% THD for linear loads.
 - 4. NFPA 101 self-testing and data logging.
 - 5. UL 924 listed.
 - 6. Automatic event, test and alarm log.
 - 7. Compatible with LED lighting loads and fractional horsepower intermittent use motors.
 - 8. No-break 2ms transfer time.
 - 9. Forced air cooling only during emergency operation; no filters required.

PART 3: EXECUTION

3.01 INSTALLATION

- A. If floor mounted install system components on 4-inch- high concrete bases. Concrete base construction requirements are specified in Division 26 Section "Hangers and Supports for Electrical Systems."
- B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.
- C. Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams, unless otherwise indicated.
- D. Installation of Equipment BACnet Interface Devices
 - 1. See Responsibility Matrix for the execution responsibilities for Equipment Supplier, Controls and Electrical Subcontractor.
 - 2. Equipment Supplier is responsible for supplying and installing the BACnet Interface Device.
 - 3. Division 25 is responsible for communicating with the BACnet Interface Device using BACnet objects and services to access this data and for mapping the BACnet objects from the device(s) in this Specification Section to the BACnet Object Integration Device to create graphics, reports, trends, alarms, schedules and other requirements specified in Division 25. Division 25 is only responsible for communicating with the BACnet Interface Device using BACnet objects and services to access this data.
 - 4. Electrical is responsible for power and any control wiring if the device does not have a single point of connection.
 - 5. This BACnet Interface Device is a BACnet/IP device. See Division 27 for networking responsibilities.

3.02 IDENTIFICATION

A. Identify components and wiring according to Division 26 Section "Identification for Electrical Systems."

3.03 FIELD QUALITY CONTROL

- A. Electrical Tests and Inspections: Perform tests and inspections according to manufacturer's written instructions and as listed below to demonstrate condition and performance of each UPS component:
 - 1. Inspect interiors of enclosures, including the following:
 - a. Integrity of mechanical and electrical connections.
 - b. Component type and labeling verification.
 - c. Ratings of installed components.
 - 2. Test manual and automatic operational features and system protective and alarm functions.
 - 3. Test communication of status and alarms to remote monitoring equipment.
- B. Retest: Correct deficiencies and retest until specified requirements are met.
- C. Record of Tests and Inspections: Maintain and submit documentation of tests and inspections, including references to manufacturers' written instructions and other test and inspection criteria. Include results of tests, inspections, and retests.

3.04 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the UPS. Refer to Division 01 Section "Demonstration and Training."
- B. Refer to Division 25 20 26.33.56 for BACnet Interface Device commissioning, demonstration and training requirements.
- C. Film training of systems as part of closeout documents. Refer to 01 79 00 Demonstration and Training for specific information.

END OF SECTION 26 33 56

SECTION 26 36 00

TRANSFER SWITCHES

PART 1: GENERAL

1.1 SCOPE

- A. This Section includes the furnishing of automatic transfer switches of the type and operating characteristics described hereinafter, completely installed, tested, and operative. All necessary equipment, labor, and materials shall be included; the coordination of all required equipment and material shall be the responsibility of one manufacturer, who has had an approved experience record in furnishing similar equipment. The automatic transfer switches shall be closed transition four pole type. The amperage, voltage, withstand, and close-on ratings shall be as shown on the plans.
- B. All system equipment, materials, and components shall be of current production models and types, produced and marketed by manufacturers having an established reputation for satisfactory product performance and reliability.
- C. The automatic transfer switches shall be used for a Level 1 emergency power supply system. Coordinate and provide all requirements with utility.

1.2 RELATED SECTIONS

- A. Division 25 Section 25 20 26.36.00 Integrated Automation BACnet Interface Device (Gateways/Native BACnet Devices) Automatic Transfer Switches (All Types).
- B. 25 00 13 Integrated Automation General Requirements All Trades Work Responsibilities.
- C. Division 25 Schedule 3 BACNET SINGLE LINE DIAGRAM AND RESPONSIBILITY MATRIX (APPLIES TO ALL TRADES.

1.3 SUBMITTALS

- A. Shop Drawings shall be submitted for each type of packaged transfer switch indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Single-Line Diagram: Show connections between transfer switch, bypass/isolation switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.
 - 3. Include the BACnet Interface Device with Submittal showing proprietary points listed in 25 20 26.36.00 are mapped to BACnet Object Types. Failure to do so will result in automatic rejection of the submittal.
- B. Qualification Data: For manufacturer.
- C. Field quality-control test reports.
- D. Operation, Maintenance, and Warranty Data: For each type of product to include in emergency, operation, maintenance and warranty data manuals. In addition to items specified in Division 01 Section "Operation, Maintenance, and Warranty Data," include the following:
 - 1. Features and operating sequences, both automatic and manual.
 - 2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.4 QUALITY ASSURANCE

A. Manufacturer of transfer switches shall be specialized in the manufacture and assembly of such equipment for a minimum of 25 years.

- B. Equipment shall be listed and/or classified by Underwriters Laboratories and in accordance with standards listed in this Specification.
- C. Installer Qualifications:
 - 1. An employer of workers qualified as defined in NEMA PB 1.1 and trained in electrical safety as required by NFPA 70E.
 - 2. Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
 - 3. Maintenance Proximity: Not more than four hours' normal travel time from Installer's place of business to Project site.
- D. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification for 365 days per year..
- E. Source Limitations: Obtain automatic transfer switches through one source from a single manufacturer.
- F. 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.
- G. Comply with NFPA 70, 99, and 110.
- H. Comply with UL 1008 unless requirements of these Specifications are stricter.

1.5 REFERENCES

- A. The products provided by this section shall comply with the following applicable references (latest edition):
 - 1. NEMA ICS1 Industrial Control and Systems.
 - 2. NEMA ICB-10-1993.
 - 3. NFPA 110 Standard for Emergency and Standby Power Systems.
 - 4. UL 1008 Transfer Switch Equipment.
 - 5. IEC 947-6-1.
 - 6. IEEE Standard 446.

1.6 MAINTENANCE

- A. Transfer switch manufacturer / vendor shall:
 - 1. Make ordering of new equipment for expansions, replacements, and spare parts available to end user.
 - 2. Make new replacement parts available for minimum of ten years from date of manufacture.
 - 3. Provide factory direct technical support hotline 24 hours per day, 7 days per week.
 - 4. Provide on-site service support within 24 hours anywhere in continental United States.
 - 5. Offer renewable service contract on yearly basis, to include parts, factory labor, and annual training visits. Make service contracts available up to ten years after date of system commissioning.
 - 6. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

1.7 COORDINATION

- A. Coordinate size and location of transfer switches. Coordinate layout and installation of transfer switch with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Mount on concrete pads where indicated. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of transfer switch(es) and associated auxiliary components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 2 years from date of Substantial Completion.

PART 2: PRODUCTS

2.1 GENERAL INFORMATION.

A. All electrical equipment and material shall be new and bear a recognized testing laboratory's label, where applicable. The type of equipment and/or material shall be designated by the location where it will be installed and so defined by NEMA / NFPA 70 standards.

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide Automatic Transfer Switches by one of the following:
 - 1. Emerson; ASCO Power Technologies, LP.
 - 2. Caterpillar; Engine Div.
 - 3. GE Zenith Controls.
 - 4. Kohler Power Systems; Generator Division.
 - 5. Onan/Cummins Power Generation; Industrial Business Group.

2.3 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

- A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.
 1. Refer to drawings for indicated ampere and voltage ratings.
- B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated 65,000 A.I.C, based on testing according to UL 1008.
- C. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.
- D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.
- E. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.
- F. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
 - 1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
 - 2. Switch Action: Double throw; mechanically held in both directions.
 - 3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transferswitch units, rated 225 A and higher, shall have separate arcing contacts. Inspection of contacts shall be possible without removing or disconnecting of conductors.
- G. Neutrals:
 - 1. Provide overlapping closed-transition neutral poles switched simultaneously with phase poles.

- H. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device. Include all controls and wiring to equipment in conduit as required.
- I. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in Division 26 Section "Identification for Electrical Systems."
 - 1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
 - 2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
 - 3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
- J. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.
 - 1. Front access only. Rear and side access not allowed.

2.4 AUTOMATIC TRANSFER SWITCHES

- A. Comply with Level 1 equipment according to NFPA 110.
- B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.
- C. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.
- D. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.
- E. Automatic Closed-Transition Transfer Switches: Include the following functions and characteristics:
 - 1. Fully automatic make-before-break operation.
 - 2. Load transfer without interruption, through momentary interconnection of both power sources not exceeding 100 ms.
 - 3. Initiation of No-Interruption Transfer: Controlled by in-phase monitor and sensors confirming both sources are present and acceptable.
 - a. Initiation occurs without active control of generator.
 - b. Controls ensure that closed-transition load transfer closure occurs only when the 2 sources are within plus or minus 5 electrical degrees maximum, and plus or minus 5 percent maximum voltage difference.
 - 4. Failure of power source serving load initiates automatic break-before-make transfer.
 - 5. Provide the following discrete relays external to the transfer switch controller/control system:
 - a. Extended parallel relay 62PL.
 - b. Lock-out relay 86.
 - c. Electrical contractor to coordinate the protective relay system with the local Utility.
- F. Automatic Transfer-Switch Features:
 - 1. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
 - 2. Over-Voltage Sensing: 120 percent pick-up; 110 percent dropout.
 - 3. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
 - 4. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator.
 - a. Pickup voltage shall be adjustable from 85 to 100 percent of nominal; factory set for pickup at 90 percent.
 - b. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
 - 5. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.

- 6. Test Switch: Simulate normal-source failure.
- 7. Switch-Position Pilot Lights: Indicate source to which load is connected.
- 8. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.
 - a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
 - b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
- 9. Auxiliary Contacts: Unassigned: Two (minimum) normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac. Assigned: As required for remote annunciation and control wiring in conduit to remove equipment as required.
- 10. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
- 11. Engine Starting Controls: One isolated and normally closed, and one isolated and normally open; rated 10A min. at 32-Vdc minimum.
- 12. Engine Shutdown Contacts: Time-delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
- 13. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
 - a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
 - b. Push-button programming control with digital display of settings.
 - c. Integral battery operation of time switch when normal control power is not available.
- 14. Load Shed Relay (LSR) Feature for Optional Branch ATS: Provide required auxiliary contacts and interface optional branch ATS with load shed relay being provided on the output of the generator such that the "Optional" branch ATS is de-energized under a Generator Overload condition. (ASCO option 30A or equal.)
- 15. Additional Operational Controls and Contacts: Provide (includes but not limited to) as follows:
 - a. Test Switch for "test," "automatic," and "reset." Label as required.
 - b. Adjustable time-delay for transferring to "emergency" and to "normal."
 - c. Adjustable time-delay for engine cool down.
 - d. Manual bypass button to allow bypass of time-delay back to normal power.
 - e. Engine start adjustable time-delay.
 - f. AC metering for amperes, voltage, frequency, running time, KVA/PF loads on each side.
 - g. Programmable Microprocessor Controlled.
- 16. Interconnection Accessories:
 - a. 62PL: Extended parallel condition indicator with alarm.
 - b. 86A: Lock-out Relay with Manual Reset. Output contacts rated 3A/125VAC. Relay will trip and lock out other devices such as circuit breaker with a fault or other predetermined condition exists.
 - c. Tech Bundle (ASCO 150A):
 - 1) 5210 Power Meter monitoring Load Side. Provides KW, KVAR, PF and Energy information.
 - 2) Ethernet Communications Module Quad-Ethernet.
 - 3) Power ride through 25 seconds minimum via internal buffer module.
 - 4) Provisions for customer supplied 24VDC backup power.
- 17. Provide BACnet Interface Devices for each Automatic Transfer Switch so that the units are presented as a series of AV, BV and MSV BACnet objects. See 25 20 26.36.00 for the list of objects that must be supported. This list is the minimum acceptable.
- 18. Provide power to BACnet Interface Device during the 10 second transfer from commercial (shore) power to APU power. This may be accomplished by using an internal battery or a supercap or some other means to ensure that the BACnet Interface Device stays powers up during the transfer process.

2.5 REMOTE ANNUNCIATOR AND CONTROL SYSTEM

- A. Functional Description: Remote annunciator panel shall annunciate conditions for indicated transfer switches. Annunciation shall include the following:
 - 1. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
 - 2. Switch position.
 - 3. Switch in test mode.

- 4. Failure of communication link.
- 5. Key-Switch on user-code access to control functions of panel.
- 6. Control of switch-test indications.
- 7. Control of switch operation in either direction.
- 8. Control of time-delay bypass for transfer to normal source.
- B. Annunciator Panel: LED-lamp type with audible signal and silencing switch.
 - 1. Indicating Lights: Grouped for each transfer switch monitored.
 - 2. Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.
 - 3. Mounting: Flush, modular, steel cabinet, unless otherwise indicated.
 - 4. Digital Communication Capability: Matched to that of transfer switches supervised.
 - 5. Lamp Test: Push-to-test or lamp-test switch on front panel.
- C. Malfunction of annunciator, annunciation and control panel, or communication link shall not affect functions of automatic transfer switch. In the event of failure of communication link, automatic transfer switch automatically reverts to stand-alone, self-contained operation. Automatic transfer-switch sensing, controlling, or operating function shall not depend on remote panel for proper operation.

2.6 SOURCE QUALITY CONTROL

A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

2.7 CONCRETE BASES

- A. Equipment Mounting (where floor-mounting is required): Install on concrete base, 4-inch nominal thickness. Comply with requirements for concrete base specified in Division 03 Section.
 - 1. Coordinate size of equipment bases with actual unit sizes provided. Fabricate base 4 inches larger in both directions than the overall dimensions of the supported unit. Chamfer top edge and corners of pad.
 - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 - 3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 5. Install anchor bolts to elevations required for proper attachment to transfer switch.

PART 3: EXECUTION

3.1 GENERAL INSTALLATION

- A. Transfer switches shall be installed in a neat and workmanlike manner. The NEIS Standard Practices for Good Workmanship in Electrical Contracting NECA 1-2006 is hereby adopted to define such workmanship and the installation of conductors and cables.
- B. Provide all equipment, wiring, conduit, and junction boxes required for the installation of a complete and operating system in accordance with applicable local, state, and national codes, the manufacturers' recommendations, these plans and specifications.
- C. Mount on 4" concrete bases where floor mounting is indicated.
- D. Installation of Equipment BACnet Interface Devices:
 - 1. See Responsibility Matrix for the execution responsibilities for Equipment Supplier, Controls and Electrical Subcontractor.
 - 2. Equipment Supplier is responsible for supplying and installing the BACnet Interface Device.

- 3. Division 25 is responsible for communicating with the BACnet Interface Device using BACnet objects and services to access this data and for mapping the BACnet objects from the device(s) in this Specification Section to the BACnet Object Integration Device to create graphics, reports, trends, alarms, schedules and other requirements specified in Division 25. Division 25 is only responsible for communicating with the BACnet Interface Device using BACnet objects and services to access this data.
- 4. Electrical is responsible for power and any control wiring if the device does not have a single point of connection.
- 5. This BACnet Interface Device is a BACnet/IP device. See Division 27 for networking responsibilities.

3.2 EXAMINATION

- A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting transfer switch performance.
- B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before transfer switch installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

- A. Comply with transfer switch manufacturers' written installation and alignment instructions and with NFPA 110. Verify / coordinate generator manufacturers' written installation and alignment instructions.
- B. Annunciator and/or Control Panel Mounting: Flush in wall, unless otherwise indicated. Provide wiring in conduit to annunciator panel. Verify wire quantity and type with manufacturer. Locate in Dispatch Room.
- C. Identify components according to Division 26 Section "Identification for Electrical Systems."
- D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.4 CONNECTIONS

- A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.
- B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- D. Provide connection to remote 24V source in exterior generator.

3.5 FIELD QUALITY CONTROL

- A. Notify commissioning agent in advance of performing tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections per requirements below. Report results in writing.
- C. Perform tests and inspections and prepare test reports.
 - 1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
 - 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 3. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
 - a. Check for electrical continuity of circuits and for short circuits.

- b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
- c. Verify that manual transfer warnings are properly placed.
- d. Perform manual transfer operation.
- 4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
 - a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
 - b. Simulate loss of phase-to-ground voltage for each phase of normal source.
 - c. Verify time-delay settings.
 - d. Verify pickup and dropout voltages by data readout or inspection of control settings.
 - e. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
- 5. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
 - a. Verify grounding connections and locations and ratings of sensors.
- D. Coordinate tests with tests of generator and run them concurrently.
- E. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.
- F. Remove and replace malfunctioning units and retest as specified above.
- G. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.
 - 1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
 - 2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 3. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- H. Include all test results in Owner's Operation, Maintenance, and Warranty Data manuals.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Division 01 Section "Demonstration and Training." Include up to 4 hours training.
- B. Coordinate this training with that for generator equipment.
- C. Refer to Division 25 20 26.36.00 for BACnet Interface Device commissioning, demonstration and training requirements.
- D. Film training of systems as part of closeout documents. Refer to 01 79 00 Demonstration and Training for specific information.

END OF SECTION 26 36 00

SECTION 26 51 00

LIGHTING

PART 1: GENERAL

1.1 SCOPE

- A. This Section includes the furnishing and installing of luminaires as shown and specified herein complete with lamps, supporting devices, and other appurtenances as required.
 - 1. Luminaires.
 - 2. LED systems.
 - 3. Exterior luminaires with integral wireless controls.
 - 4. Exit and Emergency systems.
 - 5. Luminaire supports.
 - 6. Poles, pole supports and pole accessories.
 - 7. Lighting rebate forms.

1.2 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color-rendering index.
- C. LER: Luminaire efficacy rating.
- D. Lumen: Measured output of luminaire.
- E. Luminaire: Complete lighting fixture, including driver housing if provided.

1.3 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

- A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4-M.
- B. Ice Load: Load of 3 lbf/sq. ft., applied as stated in AASHTO LTS-4-M Ice Load Map.
- C. Wind Load: Pressure of wind on pole and luminaire and banners and banner arms, calculated and applied as stated in AASHTO LTS-4-M.
 - 1. Basic wind speed for calculating wind load for poles is per AASHTO LTS-4-M. Wind Importance and Velocity Conversion Factors shall be per Table 3-2. Minimum Design Life shall be per Table 3-3.

1.4 SUBMITTALS

- A. Product Data: For each type of luminaire, pole and support component, arranged in order of luminaire designation. Include data on features, accessories, finishes, and the following:
 - 1. Physical description of luminaire including dimensions.
 - 2. Rated life, lumen output, energy, and efficiency data for LED components.
 - 3. Materials, dimensions and finishes of poles.
 - 4. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
 - 5. Manufactured pole foundations.
 - 6. Anchor bolts for poles.
 - 7. Photometric data, in IESNA format, based on laboratory tests of each luminaire type, outfitted with lamps, ballasts, and accessories identical to those indicated for the luminaire as applied in this Project. For indicated fixtures photometric data shall be certified by a qualified independent testing agency, photometric data for remaining fixtures shall be certified by manufacturer.
 - 8. Installation instructions.

- B. Shop Drawings: Show details of nonstandard or custom luminaires. Indicate plans, elevations, sections, details and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: Power, signal and control wiring.
- C. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4-M and that load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations by a professional engineer.
- D. Operation, Maintenance and Warranty Data:
 - 1. For lighting equipment and luminaires to include in emergency, operation, maintenance and warranty data manuals.
 - 2. Special warranties specified in Part 3 of this Section.
- E. Product Certificates: For each type of dimming driver and associated dimmer controller, from luminaire manufacturer.
- F. Field quality-control reports.
- G. Provide BACnet Interface Devices for each Exterior Lighting Control so that the units are presented as a series of AV, BV and MSV BACnet objects. See 25 20 26.56.00 for the list of objects that must be supported. This list is the minimum acceptable.

1.5 CLOSEOUT SUBMITTALS

- A. Lighting Rebates: Copy of completed lighting rebate forms, including all backup information and receipts.
- B. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.
 - 1. Provide record of rebate forms as part of O&M Manual. Refer to "Rebate Forms" in Part 2 below.
 - 2. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Submit record of transmittal as part of O&M Manual. Refer to "Extra Materials" article in Part 2 below.
 - 3. Submit record of warranty as part of O&M Manual. Refer to "Warranty" article in Part 1 below.

1.6 SUBSTITUTIONS

- A. Type, grade, quality and photometric data of luminaires are indicated on the Luminaire Schedules on the drawings by manufacturers' specified Catalog Numbers. Substituted luminaires including outdoor luminaires, may be required to provide "Point-By-Point" layouts. Substituted luminaire manufacturers may require additional luminaires.
- B. Luminaires not listed on the schedule shall require submittal for prior approval. Coordinate exact requirements with Engineer.
- C. All submittals for parking lot luminaires must contain calculations showing maintained horizontal footcandle levels in the parking lot, complete with all light loss factor assumptions.

1.7 QUALITY ASSURANCE

- A. The equipment manufacturer shall be regularly engaged in manufacture of luminaires, of the types and capacities required, and whose products have been in satisfactory use in similar service for not less than ten years.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70 by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

- C. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910, complying with the IESNA Lighting Measurements Testing & Calculation Guides.
- D. The products provided by this section shall comply with the following applicable references (latest edition):
 - 1. ANSI C82.SSL1: SSL Drivers
 - 2. FM Global Compliance: Lighting fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
 - 3. IES-LM-79: LED Luminaires Electrical and Photometric Measurements of Solid-State Lighting Products.
 - 4. IES-LM-80: LED Luminaires Measuring Lumen Maintenance of LED Light Sources.
 - 5. IES-TM-21: LED Luminaires Projection of LED Life.
 - 6. NEMA LE 4: Recessed Luminaires.
 - 7. NSF: Lighting fixtures for use in commercial kitchens shall be listed and labeled suitable for such use per National Sanitation Foundation standards.
 - 8. UL 924: Emergency Lighting and Power Equipment.
 - 9. UL 1598: Luminaires.

E. Source Limitations: Obtain luminaires from single source from single manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Package aluminum poles for shipping according to ASTM B 660.
- B. Store poles on decay-resistant-treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
- C. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.9 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including but not limited to structural members, HVAC equipment, fire-suppression system, and partition assemblies.

1.10 WARRANTY

- A. Special Warranty for LED Fixtures: Manufacturer's standard form, made out to Owner and signed by lamp manufacturer agreeing to replace LED and driver components, or fixture in its entirety, that either partially or entirely fails in materials or workmanship, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
 - 1. Warranty Period: 5 years from date of Substantial Completion.
- B. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Emergency Lighting Unit Batteries: 10 years from date of Substantial Completion. Full warranty shall apply for three years, and prorated warranty for the remaining seven years.
- C. Special Warranty for Exterior Luminaires, Poles and Accessories: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.
 - 1. Warranty Period for Luminaires: Five years from date of Substantial Completion.
 - 2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
 - 3. Warranty Period for Color Retention: Five years from date of Substantial Completion.

- 4. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than three years from date of Substantial Completion.
- D. Provide documentation of warranties in O&M Manual.

1.11 RELATED SECTIONS".

- A. Section 25 20 26.56.00 Integrated Automation BACnet Interface Device (Gateway/Native BACnet Devices) Exterior Lighting Controls (All Types)
- B. Section 25 00 13 Integrated Automation General Requirements All Trades Work Responsibilities.
- C. Division 25 Schedule 3 BACnet Single Line Diagram and Responsibility Matrix (Applies to all Trades).

PART 2: PRODUCTS

2.1 GENERAL INFORMATION.

- A. All electrical equipment and material shall be new and bear a recognized testing laboratory's label, where applicable. The type of equipment and/or material shall be designated by the location where it will be installed and so defined by NEMA / NFPA 70 standards. Provide quick disconnects for light luminaires for wiring as required by Code.
- B. Where screw-in LED lamps are indicated on drawings and schedules provide luminaires with lamps for each outlet as required.
- C. The type luminaires required are as noted by a capital letter on the Drawings. Contractor shall be solely responsible for the exact quantities. Any outlets not specifically noted on the Drawings shall be equipped with luminaires similar to those in rooms used for like purposes.

2.2 MANUFACTURERS

A. Products: subject to compliance with requirements below, provide products as indicated on the Drawings.

2.3 LUMINAIRES AND COMPONENTS, GENERAL REQUIREMENTS

- A. Doors, Frames, and Other Internal Access:
 - 1. Smooth operating, free of light leakage under operating conditions, and designed to permit re-lamping without use of tools unless otherwise noted. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during re-lamping and when secured in operating position.
 - 2. Lighting fixture closures (lens doors, trim frame, hinged housings, etc.) shall be retained in a secure manner by captive screws, chains, captive hinges or fasteners such that they cannot be accidentally dislodged during normal operation or routine maintenance.
- B. Metal Parts: Free of burrs and sharp corners and edges. Sheet metal shall be steel, unless otherwise indicated, and formed and supported to prevent warping and sagging.
- C. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
 - 1. White Surfaces: 85 percent.
 - 2. Specular Surfaces: 83 percent.
 - 3. Diffusing Specular Surfaces: 75 percent.
 - 4. Laminated Silver Metallized Film: 90 percent.
- D. Plastic Diffusers, Covers, and Globes:
 - 1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation. Minimum lens thickness shall be .125 inch. UV stabilized.
 - 2. Glass: Annealed crystal glass, unless otherwise indicated.

- E. Recessed fixtures mounted in an insulated ceiling shall be listed for use in insulated ceilings.
- F. Provide UL fire rated enclosure as required for luminaires installed in a rated ceiling if luminaires are not fire rated.
- G. Lighting fixtures shall have a specific means for grounding metallic wire-ways and housings to an equipment grounding conductor.
- H. Where color temperatures specified within this section differ from temperatures specified on plans the contractor shall obtain explicit verification of color temperature from engineer prior to ordering.
- I. Additional Requirements for Exterior Luminaires:
 - 1. Provide with integral wireless controls as described in 26 09 23 Lighting Control Network. Exterior wireless controls shall be part of same network as interior wired system.
 - 2. Exposed Hardware Material: Stainless steel.
 - 3. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - 4. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.
 - 5. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
 - 6. Luminaire-Mounted Photoelectric Relays (where indicated):
 - a. Comply with UL 773 or UL 773A.
 - b. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc and off at 4.5 to 10 fc with 15-second minimum time delay. Relay shall have directional lens in front of photocell to prevent artificial light sources from causing false turnoff
 - 1) Relay with locking-type receptacle shall comply with ANSI C136.10.
 - 2) Adjustable window slide for adjusting on-off set points.
 - 7. Luminaire Finish:
 - a. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
 - b. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
 - 1) Color: If not specifically indicated on plans, finish and color shall be as selected by Architect.

2.4 LED SYSTEMS

- A. Provide driver as required for proper operation of fixture:
 - 1. The driver's maximum case temperature shall not be exceeded at the maximum operating ambient. Thermal management shall be passive by design.
 - 2. The use of fans or other mechanical devices is prohibited.
- B. Technical requirements:
 - 1. Fixtures shall be tested and rated per most recent edition of IES LM-79, IES LM-80, and IES TM-21 with rated life of 70,000 hours or greater.
 - a. Assume each luminaire will operate at an average operating time of twelve hours per day.
 - b. Each luminaire is expected to have a minimal operational life of 120 months (ten years).
 - 2. The thermal management (of the heat generated by the LEDs) shall be of sufficient capacity to ensure proper operation of the luminaire over the rated life.
 - a. The maximum junction temperature for the rated life shall not be exceeded at the average operating ambient.
 - b. The maximum junction temperature for the catastrophic failure shall not be exceeded at the maximum operating ambient.
 - 3. The individual LEDs shall be connected such that a catastrophic loss or the failure of one LED will not result in the loss of the entire luminaire.
 - 4. Power Factor: The luminaire shall have a power factor of 90% or greater at all standard operating voltages.

- 5. THD: Total harmonic distortion (current and voltage) induced into an AC power line by a luminaire shall not exceed 20 percent at any standard input voltage.
- 6. Surge Suppression: The luminaire shall include surge protection to withstand high repetition noise and other interference.
 - a. The surge protection which may reside within the driver shall protect the luminaire from damage and failure for transient voltages and currents as defined in ANSI/IEEE C64.41 for Location Category A Low. Where failure does not mean a momentary loss of light during the transient event.
 - b. Surge protection performance shall be tested per the procedures in ANSI/IEEE C62.45 based on ANSI/IEEE C62.41 definitions for standard and optional waveforms for Location Category A-Low.
- 7. Operational Performance: The LED circuitry shall prevent perceptible flicker to the unaided eye over the voltage range specified above.
- 8. RF Interference: The luminaire and associated on-board circuitry must meet Class A emission limits referred in Federal Communications Commission (FCC) Title 47, Subpart B, Section 15 regulations concerning the emission of electronic noise.
- 9. Dimming (where indicated): The luminaire shall be capable of continuous dimming without perceivable flicker over a range of 100% to 5% of rated lumen output. Dimming shall be controlled by a 0-10V signal.
- 10. Lumen Management (where indicated): The luminaire shall be capable of continuously monitoring system performance to allow for constant lumen management / compensation function.
- 11. Output Color:
 - a. Interior Fixtures: Minimum CRI 80, and color temperature 4000 K and 3500K (+/- 100K) depending on area. Refer to plans and schedules.
 - b. Exterior Fixtures: Minimum CRI 70, and color temperature 4100 K (+/- 100K) unless noted otherwise.
- 12. Operating temperature (exterior and cold-weather interior fixtures only)
 - a. The operating temperature range shall be -40° F to $+130^{\circ}$ F.
 - b. Each luminaire shall be designed to operate at an average nighttime operating temperature of 70°F.
 - c. Each luminaire is expected to operate at a daytime ambient temperature of 104°F, and to comply with photometric requirements.
 - d. Parameters and tests (such as IES-LM-79, IES-LM-80and IES-TM-21) shall be conducted at 104°F ambient temperatures.
 - e. Each luminaire shall meet all parameters of this specification throughout the minimum operational life when operated at the average nighttime operating temperature.
- C. Protective Requirements for LED Systems in Pool Environments:
 - 1. Provide coating on LED boards to prevent typical pool chemicals from breaking down LED emitters.
 - 2. Provide gasketing to prevent off-gassing.
- D. Housing for Exterior LED Systems:
 - 1. The assembly and manufacturing process shall be designed to ensure all internal components are adequately supported to withstand mechanical shock and vibration.
 - 2. The electronics/power supply enclosure shall be internal to the luminaire and be accessible per UL requirements.
 - 3. The assembly and manufacturing process shall be designed to ensure all internal components are adequately supported to withstand mechanical shock and vibration from winds and other sources.
 - 4. The housing shall be designed to prevent the build-up of water on the top of the housing. Exposed heat sink fins shall be oriented so that water can freely run off the luminaire, and carry dust and other accumulated debris away from the unit.
 - 5. The optical assembly of the luminaire shall be protected against dust and moisture intrusion per the requirements of IP-65 (minimum) to protect all internal components.
 - 6. The electronics/power supply enclosure shall be protected per the requirements of IP-43 (minimum).
 - 7. When the components are mounted on a down opening door, the door shall be hinged and secured to the luminaire housing separately from the refractor or lens frame. The door shall be secured to the housing in a manner to prevent its accidental opening. A safety cable shall mechanically connect the door to the housing.

2.5 EXIT SIGNS AND EMERGENCY LIGHTING SYSTEMS

- A. Exit Signs:
 - 1. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

2. Internally Lighted Signs:

1.

- a. Universal voltage.
- b. Lamps for AC operation: LED, 50,000 hours minimum rated lamp life.
- c. Provide self-powered signs unless specifically noted on plans that signs are fed from external emergency power source and not required to contain internal batteries.
- B. Emergency Lighting Units (standalone battery wall packs):
 - Description: Self-contained units complying with UL 924.
 - a. Battery: Sealed, maintenance-free, lead-acid type.
 - b. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - c. Operation: Relay automatically turns lamp on when power supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deepdischarge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - f. Wire Guard (where indicated): Heavy-chrome-plated wire guard protects lamp heads or luminaires.
 - g. Integral Time-Delay Relay (where indicated): Holds unit on for fixed interval of 15 minutes when power is restored after an outage.
 - h. Remote Test (where indicated): Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
 - i. Integral Self-Test (where indicated): Factory-installed electronic device automatically initiates coderequired test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.6 LUMINAIRE SUPPORT COMPONENTS

- A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
- C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single luminaire. Finish same as luminaire.
- D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.
- E. Wires for Humid Spaces (where indicated): ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage.
- F. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- G. Hook Hangers: Integrated assembly matched to luminaire and line voltage and equipped with threaded attachment, cord, and locking-type plug.

2.7 POLES, POLE SUPPORTS AND POLE ACCESSORIES

- A. General Requirements for Poles and Support Components:
 - Structural Characteristics: Comply with AASHTO LTS-4-M.
 - a. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in "Structural Analysis Criteria for Pole Selection" Article.
 - b. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

1.

- 2. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.
- 3. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
 - a. Materials: Shall not cause galvanic action at contact points.
 - b. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
 - c. Anchor-Bolt Template: Plywood or steel.
- 4. Handhole: Oval-shaped, with minimum clear opening of 2-1/2 by 5 inches, with cover secured by stainless-steel captive screws.
- 5. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 03 and 32 (as applicable). Strength to be minimum of 4,500 psi.
- 6. All poles greater than 15' shall be provided with a factory installed vibration dampening device.
- 7. Shape, height and material as specified on plans:
 - a. SSS = Straight, square, steel
 - b. SRS = Straight, round, steel
 - c. TSS = Tapered, square, steel
 - d. TRS = Tapered, round, steel
 - e. SSA = Straight, square, aluminum
 - f. SRA = Straight, round, aluminum
 - g. TSA = Tapered, square, aluminum
 - h. TRA = Tapered, round, aluminum
- B. Pole Material:
 - 1. Aluminum Poles:
 - a. Provide aluminum poles unless specifically indicated on drawings.
 - b. Standard Aluminum: Seamless, extruded structural tube complying with ASTM B 429, Alloy 6063-T6 with access handhole in pole wall.
 - c. High-Strength Aluminum (where indicated): ASTM B 209 (ASTM B 209M), 5052-H34 marine sheet alloy with access handhole in pole wall.
 - 2. Steel Poles (where indicated):
 - a. Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig (317 MPa); 1piece construction up to 40 feet (12 m) in height with access handhole in pole wall.
- C. Pole Requirements:
 - 1. Shape: Tapered square, or as noted on the plans.
 - 2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
 - 3. Mast Arms: Single-arm type, continuously welded to pole attachment plate. Material and finish same as pole.
 - 4. Brackets for Luminaires: Detachable, cantilever, without underbrace.
 - a. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.
 - b. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire.
 - c. Match pole material and finish.
 - 5. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.
 - 6. Grounding and Bonding Lugs: Welded ¹/₂-inch (13-mm) threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.
 - 7. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.
 - 8. Factory-Applied Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - a. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
 - b. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.
 - c. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

- d. Color: If not specifically indicated on plans, finish and color shall be as selected by Architect from standard finishes and colors palette. Unless specifically noted, color shall apply to both luminaire and pole.
- D. Pole Accessories (where indicated):
 - 1. Duplex Receptacle: 120 V, 20 A in a weatherproof assembly complying with Division 26 Section "Wiring Devices" for ground-fault circuit-interrupter type.
 - a. Surface mounted, 24 inches above finished grade.
 - b. Nonmetallic polycarbonate plastic or reinforced fiberglass cover, color to match pole, that when mounted results in NEMA 250, Type 3R enclosure.
 - c. With cord opening.
 - d. With lockable hasp and latch that complies with OSHA lockout and tag-out requirements.
 - e. Associated minimum 1800-W transformer, protected by replaceable fuses, mounted behind access cover.
 - 2. Holders and Fuses: Provide in base of all outdoor lighting pole units. Fuseholders shall be Buss Type Tron-HEB. Fuses shall be Buss Type KTK, size according to load.
 - 3. Decorative accessories, supplied by decorative pole manufacturer, including banner arms, flag holders and ladder rests.

2.8 LIGHTING REBATE

- A. Contractor shall coordinate with the local power company and the Owner as required to obtain all applicable lamp, ballast, and lighting control rebates. Apply the Utility's applicable rebate program to the project.
 - 1. Secure maximum rebate on behalf of the Owner.
 - 2. Complete all forms necessary to secure rebates.
 - 3. All Rebates shall be made directly to the Owner.
 - 4. Provide all invoicing and product information necessary to procure rebate.
- B. Provide final copies of completed rebate forms in O&M Manual.

2.9 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Plastic Diffusers and Lenses: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 2. Globes and Guards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.
- B. Provide spare fixtures as indicated on luminaire schedule. Include ten feet of branch circuitry and all necessary labor for each fixture. For emergency and exit fixtures connected to generator systems include fifty feet of conduit and wire. Turn over unused spare fixtures to the Owner at the completion of the project.
- C. Provide documentation signed by Owner proving transmittal of the above materials from Contractor to Owner. Documentation shall include copy of "Extra Materials" article for reference. Include documentation in O&M Manual.

PART 3: EXECUTION

3.1 GENERAL INSTALLATION

- A. Luminaires shall be installed in a neat and workmanlike manner. The NEIS Standard Practices for Good Workmanship in Electrical Contracting NECA 1-2006 is hereby adopted to define such workmanship and the installation of conductors and cables.
- B. Install luminaires at locations and heights as indicated. Set units plumb, square, and level with ceilings and walls and secure in accordance with luminaire manufacturer's written instructions, applicable requirements of NEC, NECA's "Standard of Installation", NEMA standards, with recognized industry practices to ensure that lighting

luminaires fulfill requirements, and with Shop Drawings. Support luminaires in accordance with requirements of Section 16050, "Basic Electrical Materials and Methods".

- C. Provide all equipment, wiring, conduit, and junction boxes required for the installation of a complete and operating system in accordance with applicable local, state, and national codes, the manufacturers' recommendations, these plans and specifications.
- D. Luminaire types are indicated by a capital letter next to the luminaire. Small letters indicate switching patterns and numbers indicate circuit connection. Any luminaires not typed shall be assumed to be the same as adjacent luminaires or luminaires in like areas in the building.
- E. Height and Weight Considerations:
 - 1. Fixture heights are measured from finished floor to bottom of fixture, unless specifically noted otherwise.
 - 2. Where mounting heights are neither shown on electrical plans nor architectural elevations verify exact height with Architect/Engineer prior to rough-in and ordering of fixture.
 - 3. Provide luminaires and/or luminaire outlet boxes with hangers to properly support luminaire weight. If design of hangers or method of fastening, differs from what is indicated or specified herein then submit for review by Architect/Engineer.
- F. Luminaire finishes which are disturbed in any way during construction shall be touched up or refinished in a manner satisfactory to the Architect/Engineer.
- G. Adjust luminaires that require field adjustment or aiming. Include adjustment of integral photoelectric devices to prevent false operation of relay by artificial light sources, with exterior devices favoring a north orientation.
- H. Rectangular and square fixtures surface mounted or mounted in sheetrock, gypboard, plaster or similar ceilings shall be parallel or perpendicular to the building structure and accurately line up with respect to building elements and each other. If fixtures are not initially installed correctly the Contractor shall be responsible for any and all corrective work required to reinstall fixtures.
- I. Daisy-chaining of luminaires is not acceptable. Fixtures shall be whipped directly to junction boxes.

3.2 EXAMINATION / COORDINATION

- A. Examine conditions for compliance with lighting luminaire (luminaire) and ambient-temperature requirements for each luminaire.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, soffits, ceilings, floors, roofs, and parapets for suitable mounting conditions where luminaire will be installed.
- D. Examine / excavate site for suitable placement conditions for where concrete bases will be installed. Verify with civil and site plans for finish grade, curb, road, sidewalk, etc. locations.
- E. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met.
- F. Coordinate layout and installation of luminaires and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

3.3 INSTALLATION OF INTERIOR LUMINAIRES

- A. Support for Luminaires in or on Grid-Type Suspended Ceilings: Use grid as a support element.
 - 1. Install a minimum of two ceiling support system rods or wires for each luminaire. Locate not more than 6 inches (150 mm) from luminaire corners.
 - 2. Support Clips: Fasten to luminaires and to ceiling grid members at or near each luminaire corner with clips that are UL listed for the application.

- 3. Luminaires of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support luminaires independently with at least two 3/4-inch (20-mm) metal channels spanning and secured to ceiling tees.
- 4. Install flush mounted luminaires to eliminate light leakage between luminaire frame and finished surface.
- B. Support for Flush Luminaires in Plaster / Gypsum Type Suspended Ceilings: Use ceiling as a support element.
 - 1. Provide plaster frames for recessed luminaires installed in other than suspended grid type acoustical ceiling systems. Brace frames temporarily to prevent distortion during handling.
 - 2. Install flush mounted luminaires to eliminate light leakage between luminaire frame and finished surface.
- C. Suspended Luminaire Support:
 - Fasten luminaires securely to structural supports and ensure that pendant luminaires are plumb and level. Do
 not support luminaires from the ceiling system. Provide individually mounted pendant luminaires longer than
 2 feet with twin stem hangers. Provide stem hanger with ball aligners and provisions for minimum 1" vertical
 adjustment. Mount continuous rows of luminaires with an additional stem hanger greater than number of
 luminaires in the row.
 - 2. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
- D. Surface Flush mounted Luminaires:
 - 1. Support surface mounted luminaires greater than 2 feet in length at a point in addition to the outlet box luminaire stud. At surface mounted luminaires mounted over flush mounted junction box, provide opening through luminaire to junction box for wiring access.
- E. Install THHN 90°C wire minimum for wiring entering the ballast chamber such as pendant wiring, whips, flexible cords, or through ballast chambers in continuous row luminaires. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
 - 1. Connectors: Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Stds 486A and B, and the National Electrical Code.
- F. Lamping: Where specific lamp designations are not indicated, lamp units according to manufacturer's instructions.
- G. Provide guards for exit light and emergency battery wall pack light luminaires in gymnasiums and where indicated.

3.4 INSTALLATION OF EXTERIOR LUMINAIRES

- A. Building-Mounted Exterior Luminaires:
 - 1. Comply with "Installation of Interior Luminaires" above.
 - 2. In damp and wet locations seal luminaire infrastructure (i.e. knockouts, pipe and wiring entrances, etc.) as is standard industry practice to prevent water from entering luminaires.
- B. Pole Installation:
 - 1. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.
 - 2. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features, unless otherwise indicated on Drawings:
 - a. Fire Hydrants and Storm Drainage Piping: 60 inches.
 - b. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet.
 - c. Trees: 15 feet.
 - 3. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 03 and 32 (as applicable).
 - 4. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
 - a. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.

- b. Install base covers, unless otherwise indicated.
- c. Use a short piece of 1/2-inch- (13-mm-) diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.
- Raise and set poles using web fabric slings (not chain or cable).
- 6. Grounding of Poles:

5.

- a. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."
 - 1) Install grounding electrode for each pole, unless otherwise indicated.
 - 2) Install grounding conductor pigtail in the base for connecting luminaire to grounding system.
- b. Ground nonmetallic poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."
 - 1) Install grounding electrode for each pole.
 - 2) Install grounding conductor and conductor protector.
 - 3) Ground metallic components of pole accessories and foundations.
- C. Bollard Luminaire Installation:
 - 1. Align units for optimum directional alignment of light distribution.
 - 2. Install on concrete base with top 4 inches above finished grade or surface at bollard location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 and 32 (as applicable). Specific bollard-mounting details on plans supersede any conflicting information noted here.
- D. Installation Of Individual Ground-Mounting Luminaires
 - 1. Install on concrete base with as shown on drawing detail. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 and 32 (as applicable). Specific ground-mounting details on plans supersede any conflicting information noted here.
- E. Corrosion Prevention:
 - 1. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
 - 2. Steel Conduits: Comply with Division 26 Section "Raceway and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- (0.254 –mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

F. There are 2 options for BACnet interfaces for Exterior Lighting

- 1. 25 20 26.56.00 the Lighting Equipment Supplier uses networked lighting control panels for relay lighting control.
- 2. 25 20 26.24.16 Panelboards if addressable breaker panelboards are used for relay lighting control.

3.5 FIELD QUALITY CONTROL

- A. Inspect each installed luminaire for damage. Replace damaged luminaires and components. Replace luminaires that show evidence of corrosion during Project warranty period.
- B. Emergency / Egress Lighting Tests: Verify normal power operation of each luminaire after luminaires have been installed and circuits have been energized with normal power source. Interrupt electrical energy to demonstrate proper operation of emergency lighting installation. Include the following information in tests of emergency lighting equipment:
 - 1. Duration of supply.
 - 2. Low battery voltage shutdown.
 - 3. Normal transfer to battery source and retransfer to normal.
 - 4. Low supply voltage transfer.
- C. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.

- 1. Verify operation of photoelectric controls, either by observation of fixtures being on at night and off during the day, or by simulating darkness by temporarily covering photoelectric controls. Report observations in writing to Architect/Engineer.
- D. Replace or repair malfunctioning luminaires and components, then retest. Repeat procedure until all units operate properly.
- E. Replace defective and burned out lamps for a period of one year following the Date of Substantial Completion.
- F. At Date of Substantial Completion, replace lamps in lighting luminaires which are observed to be noticeably dimmed after Contractor's use and testing, as judged by Architect/Engineer.
- G. Refer to Division 1 sections for the replacement/restoration of lamps in lighting luminaires, where used for temporary lighting prior to Date of Substantial Completion.
- H. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.6 CLEANING / PROTECTION

- A. Clean luminaires of dirt and construction debris after completion of installation. Clean fingerprints and smudges from lenses. Use methods and materials recommended by manufacturer.
- B. Protect luminaires before, during and after installation from construction dust and debris.
- C. Clean all luminaire surfaces, lenses and/or louvers after completion of construction.
- D. Protect installed luminaires from damage during remainder of construction period.

3.7 DEMONSTRATION

- A. Upon completion of installation of luminaires, and after building circuitry has been energized, apply electrical energy to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then re-test to demonstrate compliance; otherwise, remove and replace with new units, and proceed with re-testing.
- B. Film training of systems as part of closeout documents. Refer to 01 79 00 Demonstration and Training for specific information.

END OF SECTION 26 51 00

SECTION 28 31 11

FIRE ALARM SYSTEMS

PART 1: GENERAL

1.1 SUMMARY

- A. System Description:
 - 1. Noncoded, UL-Certified or FMG-placarded addressable system, with multiplexed signal transmission, dedicated to fire-alarm service only. Fire alarm system design shall be approved by the authorities having jurisdiction.
 - 2. Areas noted on plan as Designated Critical Operations Area (DCOA) shall comply with NFPA 70 Article 708 Critical Operations Power Systems (COPS).
- B. Provide complete addressable fire alarm system, including but not limited to:
 - 1. Fire-alarm control unit.
 - 2. Voice annunciation module.
 - 3. Manual fire-alarm boxes.
 - 4. System smoke detectors.
 - 5. Multicriteria detectors.
 - 6. Low-frequency sounder bases.
 - 7. Notification appliances.
 - 8. Magnetic door holders.
 - 9. Remote annunciator.
 - 10. Addressable interface devices.
 - 11. Alarm transmitter.
 - 12. VESDA and clean agent system interconnections.
 - 13. BACnet Interface Devices.

1.2 RELATED SECTIONS

- A. Section 25 20 28.31.11 Integrated Automation BACnet Interface Device (Gateways/Native BACnet Devices) Fire Detection and Alarm (All Types).
- B. 25 00 13 Integrated Automation General Requirements All Trades Work Responsibilities.
- C. Division 25 Schedule 3 BACNET SINGLE LINE DIAGRAM AND RESPONSIBILITY MATRIX (APPLIES TO ALL TRADES).

1.3 DEFINITIONS

- A. NICET: National Institute for Certification in Engineering Technologies.
- B. Non-proprietary system: Open source system where parts, supplies, programming and all other portions and aspects of the systems are available from multiple independent, competitive dealers.

1.4 SUBMITTALS

- A. General Submittal Requirements:
 - 1. Shop Drawings shall be prepared by persons with the following qualifications:
 - a. Trained and certified by manufacturer in fire-alarm system design.
 - b. NICET-certified fire-alarm technician, Level III minimum.
- B. Product Data: For each type of product indicated.

- C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, required clearances, method of field assembly, components, control panel arrangements, and location and size of each field connection.
 - 2. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.
 - 3. Device Address List: Coordinate with final system programming.
 - 4. Sensor / detector detection patterns and adjustment ranges.
 - 5. Include voltage drop calculations for notification appliance circuits.
 - 6. Include battery-size calculations.
 - 7. Include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
 - 8. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.
 - 9. Include signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
 - 10. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.
 - 11. Wiring Diagrams: While "typical" connections and circuits are of interest, a complete system Shop Drawing shall be prepared for this particular project which includes device layout, point-to-point wiring diagram(s), and conductor sizes and types. For power, signal, and control wiring.
 - a. Identify terminals to facilitate installation, operation, and maintenance.
 - b. Single-line diagram showing interconnection of components.
 - c. Cabling diagram showing cable routing.
 - 12. Include the BACnet Interface Device with Submittal showing proprietary points listed in 25 20 28.31.11 are mapped to BACnet Object Types. Failure to do so will result in automatic rejection of the submittal.
- D. Samples of any or all proposed system components shall be submitted for examination/approval as requested.
- E. Qualification Data: For qualified installer. Provide NICET III and manufacturer certification credentials of staff assigned to project. Provide low voltage licensure credentials.
- F. Upon completion of the shop drawings, submit to the reviewing agencies for approval. The reviewing authorities may include the following:
 - 1. State Fire Marshal
 - 2. City/Local Fire Marshal
 - 3. Health and Building Department
- G. Submit copies of the shop drawing submittal to the Engineer. Copies submitted shall be stamped "approved" by each of the reviewing agencies. "Approved" copies submitted shall include copies of the agencies reviewer comments.

1.5 CLOSEOUT SUBMITTALS

- A. Field quality-control reports.
- B. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, maintenance and warranty data manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Record, 'As-built', drawings.
 - 2. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
 - 3. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
 - 4. Record copy of site-specific software.
 - 5. Device address list.

- 6. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:
 - a. Frequency of testing of installed components.
 - b. Frequency of inspection of installed components.
 - c. Requirements and recommendations related to results of maintenance.
 - d. Manufacturer's user training manuals.
- 7. Manufacturer's required maintenance related to system warranty requirements.
- 8. Abbreviated operating instructions for mounting at fire-alarm control unit.
- C. Fire Alarm Placard: Submit placard as described in Part 2.

1.6 QUALITY ASSURANCE

- A. The products provided by this section shall comply with the following applicable references (latest edition):
 - 1. NFPA 72 Fire Alarm Code
 - 2. NICET: National Institute for Certification in Engineering Technologies.
 - 3. UL 864 Standard for Control Units and Accessories for Fire Alarm Systems
- B. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project. Installer shall have a minimum of five years documented experience. Supervision of installers shall be by personnel certified by NICET as fire-alarm Level III minimum technician.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company or in the form of a placard by an FMG-approved alarm company.
- E. The equipment manufacturer shall be regularly engaged in manufacture of fire alarm systems, of the types and capacities required, and whose products have been in satisfactory use in similar service for not less than ten years.
- F. Source Limitations: Obtain fire alarm system from single source from single manufacturer.

1.7 SOFTWARE SERVICE AGREEMENT

- A. Comply with UL 864.
- B. Technical Support: Beginning with Substantial Completion, provide software support for two years.
- C. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
 - 1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

1.8 COORDINATION

A. Coordinate layout and installation of system components and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2: PRODUCTS

2.1 GENERAL INFORMATION.

A. All electrical equipment and material shall be new and bear a recognized testing laboratory's label, where applicable. The type of equipment and/or material shall be designated by the location where it will be installed and so defined by NEMA / NFPA 70 standards.

2.2 MANUFACTURERS

- A. Subject to compliance with requirements, provide products by one of the following:
 - 1. SimplexGrinnell LP; a Tyco International company.
 - a. 4100U or latest version c/w onboard UL 864 approved FieldServer BACnet Interface Device.
 - 2. No equals.

2.3 SYSTEMS OPERATIONAL DESCRIPTION

- A. Fire-alarm signal initiation shall be by one or more of the following devices and systems
 - 1. Manual stations.
 - 2. Heat detectors.
 - 3. Smoke detectors.
 - 4. Duct smoke detectors.
 - 5. Verified automatic alarm operation of smoke detectors.
 - 6. Automatic sprinkler system water flow.
 - 7. Fire-extinguishing system operation.
 - 8. Fire standpipe system.
- B. Fire-alarm signal shall initiate the following actions:
 - 1. Continuously operate alarm notification appliances.
 - 2. Broadcast live or prerecorded voice messages.
 - 3. Identify alarm at fire-alarm control unit and remote annunciators.
 - 4. Transmit an alarm signal to the remote alarm receiving station.
 - 5. Unlock electric door locks in designated egress paths.
 - 6. Release fire and smoke doors held open by magnetic door holders.
 - 7. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
 - 8. Close smoke dampers in air ducts of designated air-conditioning duct systems.
 - 9. Record events in the system memory.
- C. Supervisory signal initiation shall be by one or more of the following devices and actions:
 - 1. Valve supervisory switch.
 - 2. Low-air-pressure switch of a dry-pipe sprinkler system.
- D. System trouble signal initiation shall be by one or more of the following devices and actions:
 - 1. Open circuits, shorts, and grounds in designated circuits.
 - 2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
 - 3. Loss of primary power at fire-alarm control unit.
 - 4. Ground or a single break in fire-alarm control unit internal circuits.
 - 5. Abnormal ac voltage at fire-alarm control unit.
 - 6. Break in standby battery circuitry.
 - 7. Failure of battery charging.
 - 8. Abnormal position of any switch at fire-alarm control unit or annunciator.
 - 9. Fire-pump power failure, including a dead-phase or phase-reversal condition.
 - 10. Low-air-pressure switch operation on a dry-pipe or preaction sprinkler system.
- E. System Trouble and Supervisory Signal Actions: Initiate notification appliance and annunciate at fire-alarm control unit and remote annunciators.
- F. Door Controls:
 - 1. Door hold-open devices that are controlled by smoke detectors at doors in smoke barrier walls shall be connected to fire-alarm system.
 - 2. Provide delayed egress interconnections with security system as required, refer to fire alarm plans for specific locations.

- G. HVAC Unit Shutdown:
 - 1. Provide local actuation type smoke duct detector within the return ductwork of every mechanical unit exceeding 2,000 CFM.
 - 2. Upon alarm condition, the fire alarm system shall de-energize all HVAC units that exceed 2000 CFM.
- H. Sprinkler System Motorized Valve:
 - 1. Provide control module with relay for signal wiring.
 - 2. Fire alarm system shall be programmed for relay to be initiated by the desired fire alarm monitoring points (flow switches typically).
 - 3. Fire alarm relay shall open/close valve.
 - 4. Valve shall be powered open from a 120VAC emergency power circuit (where available) to avoid nuisance closures when the power goes out.

2.4 FIRE-ALARM CONTROL UNIT

- A. General Requirements for Fire-Alarm Control Unit:
 - 1. Field-programmable, microprocessor-based, modular, power-limited, design with electronic modules, complying with UL 864 and listed and labeled by an NRTL.
 - a. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
 - b. Include a real-time clock for time annotation of events on the event recorder and printer.
 - Addressable initiation devices that communicate device identity and status.
 - a. Smoke sensors shall additionally communicate sensitivity setting.
 - b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.
 - 3. Addressable control circuits for operation of mechanical equipment.
 - 4. Provide BACnet Interface Devices for each Fire Detection and Alarm so that the units are presented as a series of AV, BV and MSV BACnet objects. See 25 20 28.31.11 for the list of objects that must be supported. This list is the minimum acceptable. All BACnet devices point names shall follow the Lake County Simplex naming and numbering convention.
- B. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
 - 1. Annunciator and Display: Liquid-crystal type, 3 lines of 80 characters, minimum.
 - 2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.
- C. Provide voice annunciation expansion module including all necessary components. Size to meet project conditions.
 - 1. Interconnect with fire alarm control panel as required.
 - 2. Minimum ten standard pre-recorded messages, and ability to broadcast live or custom-recorded messages.
 - 3. Multi-language capabilities.
 - 4. Provide remote microphone expansion module controls and associated equipment. With system status LEDs, key switch controls, printed/engraved operating instructions and push-to-talk input microphone.
 - 5. Provide remote booster amplifiers sized as required.
- D. Circuits:

2.

- 1. Initiating Device, Notification Appliance, and Signaling Line Circuits:
 - a. Designated Critical Operations Area: NFPA 72, Class A. Cables shall be riser rated and a listed 2-hour electriacl circuit protective system.
 - b. All other areas: NFPA 72, Class B.
 - c. Signaling Line Circuits: Style 6
 - d. Maintain 25% spare capacity on each addressable loop.
- E. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

- F. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory and digital alarm communicator transmitters shall be powered by 24-V dc source.
 - 1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.
- G. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
 1. Batteries: Sealed lead calcium.
- H. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.5 MANUAL FIRE-ALARM BOXES

- A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
 - 1. Single-action mechanism, pull-lever type; with integral addressable module arranged to communicate manualstation status (normal, alarm, or trouble) to fire-alarm control unit.
 - 2. Station Reset: Key- or wrench-operated switch.
 - 3. Indoor Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.

2.6 SYSTEM SMOKE DETECTORS

- A. General Requirements for System Smoke Detectors:
 - 1. Comply with UL 268; operating at 24-V dc, nominal.
 - 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to firealarm control unit.
 - 3. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
 - 4. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
 - 5. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status.
- B. Photoelectric Smoke Detectors:
 - 1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
 - 2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).
- C. Duct Smoke Detectors: Photoelectric type complying with UL 268A.
 - 1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
 - 2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).
 - 3. Weatherproof Duct Housing Enclosure: UL Listed to standard 268A.

- 4. Each sensor shall have multiple levels of detection sensitivity.
- 5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
- 6. Relay Fan Shutdown: In addition to signaling the fire alarm control panel, the duct smoke detector shall shut the unit down on activation of the duct smoke detector Provide interface module as required. Rated to interrupt fan motor-control circuit.

2.7 HEAT DETECTORS

- A. General Requirements for Heat Detectors: Comply with UL 521.
- B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F or a rate of rise that exceeds 15 deg F per minute unless otherwise indicated.
 - 1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
 - 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to firealarm control unit.
- C. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F.
 - 1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
 - 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to firealarm control unit.

2.8 NOTIFICATION APPLIANCES

- A. General Requirements for Notification Appliances:
 - 1. Connected to notification appliance signal circuits, zoned as indicated, equipped for mounting as indicated and with screw terminals for system connections.
 - 2. Engraved with the word "ALERT" in minimum 1-inch-high letters.
- B. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a maximum sound pressure level of 90 dBA, measured 10 feet from the horn, using the coded signal prescribed in UL 464 test protocol.
 - 1. Decibel levels shall be capable of being adjusted lower to a level required by code or occupant. Verify setting levels with AHJ prior to installation and testing. Typically set on lowest level.
- C. Voice:
 - 1. High quality voice and tone reproduction with taps for ¹/₄, ¹/₂, 1, 2 or 4W, at 25 or 70.7 VRMS. Provide wattage as required to exceed ambient noise levels per manufacturer's tables and recommendations.
 - 2. Fire alarm supplier to provide plan stating appropriate tap settings at each specified location, including provision of additional devices as required for intelligibility.
 - 3. Set speaker wattage taps to provide 15 dBA above ambient sound levels.
- D. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate.
 - 1. Rated Light Output:
 - a. 15/30/75/110 cd, selectable in the field.
 - 2. Mounting: Wall or ceiling mounted as indicated on plans.
 - 3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
 - 4. Flashing shall be in a temporal pattern, synchronized with other units.
 - 5. Strobe Leads: Factory connected to screw terminals.
 - 6. Mounting Faceplate:
 - a. Ceiling: Factory finished, white.
 - b. Wall: Factory finished, red.
- E. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated and with screw terminals for system connections. Combination devices shall be capable of having the horn silenced while the strobe remains active.

F. Exterior Devices: Exterior devices shall be exterior-rated weather-resistant type.

2.9 NOTIFICATION APPLIANCE CIRCUIT (NAC) PANEL

- A. Supplemental Notification Appliance Circuit (NAC) panel shall offer 8.0 amps (6.0 amps continuous) of regulated 24-volt power. The NAC panel shall include the following features:
 - 1. Be capable of supplying (4) class 'B' circuits.
 - 2. Integral Charger: Charge up to 18.0 amp-hour batteries and support 24-hour standby.
 - 3. Input Triggers. Input trigger shall be Notification Appliance Circuit (from fire alarm control panel) or relay.
 - 4. Surface-mount back box.
 - 5. Ability to delay AC fail delay in accordance with applicable NFPA requirements.
 - 6. Power limited circuitry in accordance with applicable UL standards.
 - 7. Contain built-in synchronization and operates as sync follower or a sync generator. Provide in all spaces that contain three or more simultaneously-visible strobe devices.

2.10 MAGNETIC DOOR HOLDERS

- A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.
 - 1. Electromagnet: Requires no more than 3 W to develop 25-lbf holding force.
 - 2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
 - 3. Rating: 24-V dc.
- B. Material and Finish: Match door hardware.

2.11 REMOTE ANNUNCIATORS

- A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.
 - 1. Mounting: Flush cabinet, NEMA 250, Type 1.
- B. Refer to Mass Notification article below for additional requirements.
- C. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.12 ADDRESSABLE INTERFACE DEVICE

- A. Description: Microelectronic monitor module, UL listed for use in providing a system address for alarm-initiating devices for wired applications with normally open contacts.
- B. Integral Relay: Capable of providing a direct signal to elevator recall, air handler shutdown, kitchen hood shunt-trip breaker, door access, nurse call system etc.

2.13 MASS NOTIFICATION REQUIREMENTS

- A. Provide the following additional features in the main fire alarm control panel and in each remote fire alarm annunciator panel:
 - 1. Emergency voice/alarm communications and a microphone for Fire Department / Dispatch Manager use.
 - 2. The ability to generate a building-wide three second continuous alert tone. This alert tone shall be significantly different from the fire alarm system's three-pulse temporal pattern evacuation tone.
 - 3. A minimum of 8 pushbuttons to initiate the amber alert strobe lights and the building-wide evacuation or alert tone followed by a unique pre-recorded voice message.
 - a. Actuation of any pushbutton shall override any fire alarm notification and instead initiate the amber alert strobe lights and the building-wide evacuation or alert tone over the fire alarm system speakers. The associated pre-recorded voice message shall alternate with the tone.
 - b. Alarm and supervisory signals shall be sent through the network to the Fire Department.

- c. At any time during the alert, actuation of any microphone shall permit building-wide live voice announcements to be made. If at any time a remote annunciator panel microphone is keyed simultaneously with the main fire alarm control panel microphone, the main fire alarm control panel microphone shall have priority.
- d. The strobe lights shall continue to flash and the tone and pre-recorded voice message shall continue to sound until the fire alarm system is reset.
- 4. The tone and pre-recorded voice message shall be as follows for each pushbutton:
 - a. Alert tone alternating with "Your attention please A tornado warning has been issued. Take shelter in this building now. Remain calm and do not run. Take shelter now."
 - b. Alert tone alternating with "Your attention please An armed intruder has been reported in this area. Lockdown now."
 - c. Alert tone alternating with "Your attention please An active shooter has been reported in this area. Lockdown now."
 - d. Evacuation tone alternating with "Your attention please An emergency has occurred. Evacuate the building now. Remain calm and do not run. Evacuate now."
 - e. Alert tone alternating with "Your attention please An emergency has occurred. Please remain in place until further notice. Please remain where you are."
 - f. Alert tone alternating with "Your attention please An emergency has occurred. Take shelter in this building now. Remain calm and do not run. Take shelter now."
 - g. Alert tone alternating with "Your attention please This is an all clear. The emergency has been resolved. Resume normal operations."
 - h. Alert tone alternating with "Your attention please This is a test of the building mass notification system. This is only a test."
- B. Provide a remote microphone cabinet with microphone for Facility Manager use at the location shown on the drawings. The cabinet shall include the following features:
 - 1. Provide a minimum of 8 pushbuttons. These pushbuttons shall be identical to those in the main fire alarm panel and in each remote fire alarm annunciator panel. Each pushbutton shall be capable of initiating the building-wide evacuation or alert tone followed by the same unique pre-recorded voice message.
 - a. Actuation of any pushbutton shall override any fire alarm notification and instead initiate the amber alert strobe lights and the building-wide tone over the fire alarm system speakers. The associated pre-recorded voice message shall alternate with the tone.
 - b. Alarm and supervisory signals shall be sent through the Fire Department.
 - c. At any time during the alert, actuation of the facility manager's microphone shall permit building-wide live voice announcements to be made. If at any time the facility manager's microphone is keyed simultaneously with the main fire alarm control panel or any remote fire alarm annunciator panel microphone, the fire alarm panel microphone(s) shall have priority.
 - d. The strobe lights shall continue to flash and the tone and pre-recorded voice message shall continue to sound until the fire alarm system is reset.
 - 2. Provide a uniquely keyed cabinet door lock and special facility manager keys so a fire alarm panel key or a special Facility Manager key can access this cabinet, but a Facility Manager's key cannot access the other fire alarm panels.
- C. Provide the capability inside the main fire alarm control panel to add a future interface module or circuit card. This interface shall permit the Owner to actuate the amber alert strobe lights, actuate the building-wide evacuation or alert tone, actuate any of the pre-recorded voice messages, and make live voice announcements from a head end device located at one or more Owner remote locations. This capability shall include:
 - 1. Physical space inside the fire alarm control panel.
 - 2. Power supply capacity.
 - 3. Means to plug the interface into the fire alarm control panel circuitry.
- D. Provide system interconnecting raceways, wiring and routing in compliance with the system "survivability" requirements contained in NFPA 72.
- E. Provide a minimum of 25 BACnet objects for the Mass Notification controller board. Provide manufacturer standard BACnet points for the new devices such as the speakers.

2.14 DIGITAL ALARM COMMUNICATOR TRANSMITTER

- A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632.
- B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture two telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.
- C. Local functions and display at the digital alarm communicator transmitter shall include the following:
 - 1. Verification that both telephone lines are available.
 - 2. Programming device.
 - 3. LED display.
 - 4. Manual test report function and manual transmission clear indication.
 - 5. Communications failure with the central station or fire-alarm control unit.
- D. Digital data transmission shall include the following:
 - 1. Address of the alarm-initiating device.
 - 2. Address of the supervisory signal.
 - 3. Address of the trouble-initiating device.
 - 4. Loss of ac supply or loss of power.
 - 5. Low battery.
 - 6. Abnormal test signal.
 - 7. Communication bus failure.
- E. Secondary Power: Integral rechargeable battery and automatic charger.
- F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.15 RADIO ALARM TRANSMITTER

- A. Transmitter shall comply with NFPA 1221 and shall be UL listed.
- B. Comply with 47 CFR 90.
- C. Description: Manufacturer's standard commercial product; factory assembled, wired, tested, and ready for installation and operation.
 - 1. Packaging: A single, modular, NEMA 250, Type 1 metal enclosure with a tamper-resistant flush tumbler lock.
 - 2. Signal Transmission Mode and Frequency: VHF or UHF 2-W power output, coordinated with operating characteristics of the established remote alarm receiving station designated by Owner.
 - 3. Normal Power Input: 120-V ac.
 - 4. Secondary Power: Integral-sealed, rechargeable, 12-V battery and charger. Comply with NFPA 72 requirements for battery capacity; submit calculations.
 - 5. Antenna: Omnidirectional, coaxial half-wave, dipole type with driving point impedance matched to transmitter and antenna cable output impedance. Wind-load strength of antenna and mounting hardware and supports shall withstand 100 mph with a gust factor of 1.3 without failure.
 - 6. Antenna Cable: Coaxial cable with impedance matched to the transmitter output impedance.
 - 7. Antenna-Cable Connectors: Weatherproof.
 - 8. Alarm Interface Devices: Circuit boards, modules, and other auxiliary devices, integral to the transmitter, matching fire-alarm and other system outputs to message-generating inputs of the transmitter that produce required message transmissions.

- D. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit or from its own internal sensors or controls and shall automatically transmit signal along with a unique code that identifies the transmitting station to the remote alarm receiving station. Transmitted messages shall correspond to standard designations for fire-reporting system to which the signal is being transmitted and shall include separately designated messages in response to the following events or conditions:
 - 1. Transmitter Low-Battery Condition: Sent when battery voltage is below 85 percent of rated value.
 - 2. System Test Message: Initiated manually by a test switch within the transmitter cabinet, or automatically at an optionally preselected time, once every 24 hours, with transmission time controlled by a programmed timing device integral to transmitter controls.
 - 3. Transmitter Trouble Message: Actuated by failure, in excess of one-minute duration, of the transmitter normal power source, derangement of the wiring of the transmitter, or any alarm input interface circuit or device connected to it.
 - 4. Local Fire-Alarm-System Trouble Message: Initiated by events or conditions that cause a trouble signal to be indicated on the building system.
 - 5. Local Fire-Alarm-System Alarm Message: Actuated when the building system goes into an alarm state. Identifies device that initiated the alarm.
 - 6. Local Fire-Alarm-System Supervisory-Alarm Message: Actuated when the building alarm system indicates a supervisory alarm.

2.16 CONDUIT AND WIRING

- A. Wiring shall meet or exceed requirements of NEC Article 760.
- B. Conduits shall be used for all fire alarm circuits. Conduits shall be red in color.
 - 1. Between FACP and FAAP.
 - 2. Between FACP and power supply(s).
 - 3. Between FACP, Remote Communication Module, and telephone service point.
 - 4. All Initiating, Notification, and Control and Signal circuits.
- C. Wiring Method: Install cables in raceways except within cabinets. Conceal raceways except in unfinished spaces. Provide wiring in red conduit. Exposed cabling is not allowed.
 - 1. General Requirements:
 - a. Material; Copper.
 - b. Type: THHN/THWN in EMT conduit.
 - c. Insulation: 300V minimum, rated at 105°C.
 - 2. Initiating circuits (24V dc):
 - a. Size: 16 AWG twisted shielded pair.
 - 1) If devices require a 24V dc power supply independent of communication wiring, provide 2conductor 14 AWG from power supply.
 - 3. Notification circuits (24V dc):
 - a. Size: 2-conductor 14 AWG.
 - b. Each circuit shall have 40% spare capacity.
 - c. Voltage drop shall not cause any device to operate below its minimum rated voltage.
 - 4. Control and Signal circuits (24V dc or 120V ac):
 - a. Size:
 - 1) Power: 2-conductor 14 AWG 2-conductor.
 - 2) Control: 16 AWG twisted shielded pair.
 - b. Do not run AC and DC circuits inside the same raceway.
 - 5. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

2.17 FIRE ALARM PLACARD

- A. Provide a fire alarm zone map next to the fire alarm control panel. Map(s) shall show what areas of the building are covered by the system(s) installed. Maps shall be accurate, legible and easily understood. They shall be laminated and permanently attached to the wall in the FACP/Riser room. The maps shall include the following minimum items:
 - 1. Building layout.
 - 2. Stairwell identification.
 - 3. Location of fire-rated walls and their ratings.
 - 4. Final room numbers (may differ from floor plan room numbers).
 - 5. Knox Box location(s).
 - 6. Adjacent streets, with designators.
 - 7. North arrow.
 - 8. Legend of symbols.
 - 9. Date drawing was created.
 - 10. FACP.
 - 11. NAC panels.
 - 12. Addressable fire alarm system device ID's.
 - 13. Fire sprinkler riser locations.
 - 14. Fire pump location.
 - 15. Range hood suppression system locations.
 - 16. Clean agent system locations.
 - 17. VESDA system locations.
 - 18. Clean agent system locations.
 - 19. Dry pipe system locations.
 - 20. Related information as requested by Fire Marshal.

PART 3: EXECUTION

3.1 GENERAL INSTALLATION

- A. The fire alarm system shall be installed in a neat and workmanlike manner. The NEIS Standard Practices for Good Workmanship in Electrical Contracting NECA 1-2006 is hereby adopted to define such workmanship and the installation of conductors and cables.
- B. Provide all equipment, wiring, conduit, and junction boxes required for the installation of a complete and operating system in accordance with applicable local, state, and national codes, the manufacturers' recommendations, these plans and specifications.
- C. Installation of Equipment BACnet Interface Devices.
 - 1. See Responsibility Matrix for the execution responsibilities for Equipment Supplier, Controls and Electrical Subcontractor.
 - 2. Equipment Supplier is responsible for supplying and installing the BACnet Interface Device.
 - 3. Division 25 is only responsible for communicating with the BACnet Interface Device using BACnet objects and services to access this data.
 - 4. Electrical is responsible for power and any control wiring if the device does not have a single point of connection.
 - 5. This BACnet Interface Device is a BACnet/IP device. See Division 27 for networking responsibilities.

3.2 EXAMINATION

- A. Examine conditions for compliance with fire alarm components and ambient-temperature requirements for each component.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where components will be installed.
- D. Division 25 is responsible for communicating with the BACnet Interface Device using BACnet objects and services to access this data and for mapping the BACnet objects from the device(s) in this Specification Section to the BACnet Object Integration Device to create graphics, reports, trends, alarms, schedules and other requirements specified in Division 25. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met.

3.3 EQUIPMENT AND CABLE INSTALLATION

- A. Comply with NFPA 72 for installation of fire-alarm equipment.
- B. Equipment Mounting: Install fire-alarm control and annunciation units on wall with top of cabinets not more than 72 inches above the finished floor.
- C. Smoke- or Heat-Detector Spacing:
 - 1. Comply with NFPA 72, "Smoke-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for smoke-detector spacing.
 - 2. Comply with NFPA 72, "Heat-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for heatdetector spacing.
 - 3. Smooth ceiling spacing shall not exceed 30 feet.
 - 4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix A in NFPA 72.
 - 5. HVAC: Locate detectors not closer than 5 feet from air-supply diffuser or return-air opening.
 - 6. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture.
 - 7. At rated doors locate ceiling smoke detector per the following criteria, in order of importance:
 - a. Within five feet of door.
 - b. Greater than three feet from mechanical diffusers.
 - c. Centered on doorway.
- D. Audible & Visible Notification Device settings:
 - 1. Fire alarm installer shall be responsible for verifying appropriate decibel and candela ratings for each space. Where levels are uncomfortable or non-conforming to code the fire alarm installer shall adjust or replace unit such that appropriate levels are provided in each space.
- E. NAC Panel Requirements:
 - 1. Provide NAC panels as required to meet calculated loads.
 - 2. Provide smoke detector (not shown on plans) at each NAC panel.
- F. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct.
 - 1. Provide remote test switches for duct smoke detectors mounted 10' or more above finished floor.
 - 2. Provide duct extension as required if duct size is too small for detector installation. Coordinate with mechanical contractor.
- G. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within a dwelling or suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms to sound.
- H. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position. Label to indicate associated unit.
- I. Audible, Visible and Combination Alarm-Indicating Devices: Install as indicated on ceiling or on walls not less than 6 inches below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.
- J. Device Location-Indicating Lights: Locate in public space near the device they monitor.

- K. Antenna for Radio Alarm Transmitter: Mount to building structure where indicated. Use mounting arrangement and substrate connection that will resist 100-mph wind load with a gust factor of 1.3 without damage.
- L. Magnetic Door Holders: Mount to building structure to prevent loosening of device over time. Do not mount solely from wall material.
- M. General Cable Installation Requirements:
 - 1. Terminate conductors; no cable shall contain un-terminated elements. Make terminations only at outlets and terminals.
 - 2. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Cables may not be spliced.
 - 3. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
 - 4. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
 - 5. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used.
 - 6. Refer to 26 05 19 "Electrical Power Conductors" for additional cabling requirements.

3.4 CONNECTIONS

- A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Division 08 Section "Door Hardware." Connect hardware and devices to fire-alarm system.
 - 1. Verify that hardware and devices are UL listed for use with fire-alarm system in this Section before making connections.
- B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 3 feet from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled. Devices not necessarily shown on plans.
 - 1. Smoke dampers in air ducts of designated air-conditioning duct systems.
 - 2. Supervisory connections at valve supervisory switches.
 - 3. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
 - 4. Supervisory connections at fire-pump engine control panel.
 - 5. Connections at doors with access control to release during fire.
- C. Provide electrical connections to the following equipment. Connections not necessarily shown on plans. Connect 120V power to emergency generator panels if available. Provide lock-out clamps for all 120V circuits.
 - 1. 120V for fire alarm control panel (dedicated circuit).
 - 2. 120V for fire/smoke dampers provided by Div 23.
 - 3. 120V for heated enclosures for weatherproof duct detectors.
 - 4. 120V (or as shown on plans) for dry-type system compressor.
 - 5. 120V for NAC panels.
 - 6. 24V for door magnetic hold opens.
 - 7. Analog telephone lines (quantity two) to fire alarm transmitter.
 - 8. Digital network drops (quantity two) to web interface card (if included, see transmitter article above).

3.5 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
 - 1. Provide panel and circuit number labeling for FACP and all NAC panels.
- B. Paint all fire alarm coverplates red.
- C. Install fire alarm placard.
- D. Install framed instructions in a location visible from fire-alarm control unit.

E. Final Owner Room Numbering: All labeling, identification or programming related to room numbering shall follow the Owner's final room numbering scheme. Obtain documentation of Owner's final room numbering prior to final labeling and/or programming. Identification of all systems shall utilize Owner's final room numbers.

3.6 GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

3.7 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
 - 2. Visual Inspection: Conduct visual inspection prior to testing.
 - a. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.
 - b. Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
 - 3. System Testing: Comply with "Test Methods" Table in the "Testing" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
 - 4. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
 - 5. Test audible appliances for the private operating mode according to manufacturer's written instructions.
 - 6. Test visible appliances for the public operating mode according to manufacturer's written instructions.
 - 7. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
- B. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
- C. Fire-alarm system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. Maintenance Test and Inspection: For one year after Substantial Completion perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.
- F. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.8 START-UP SERVICE

- A. Perform startup service.
 - 1. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements.
 - 2. Complete installation and startup checks according to manufacturer's written instructions.

3.9 ADJUSTING/PROGRAMMING

- A. On-Site Assistance: Provide on-site assistance in adjusting sensors and adjusting controls to meet occupancy conditions.
- B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other-than-normal occupancy hours for this purpose.

C. Coordinate all zone names and extension numbers with Owner prior to programming. Provide digital and hard copy of fire alarm initiation device address and notification circuit number with closeout documents.

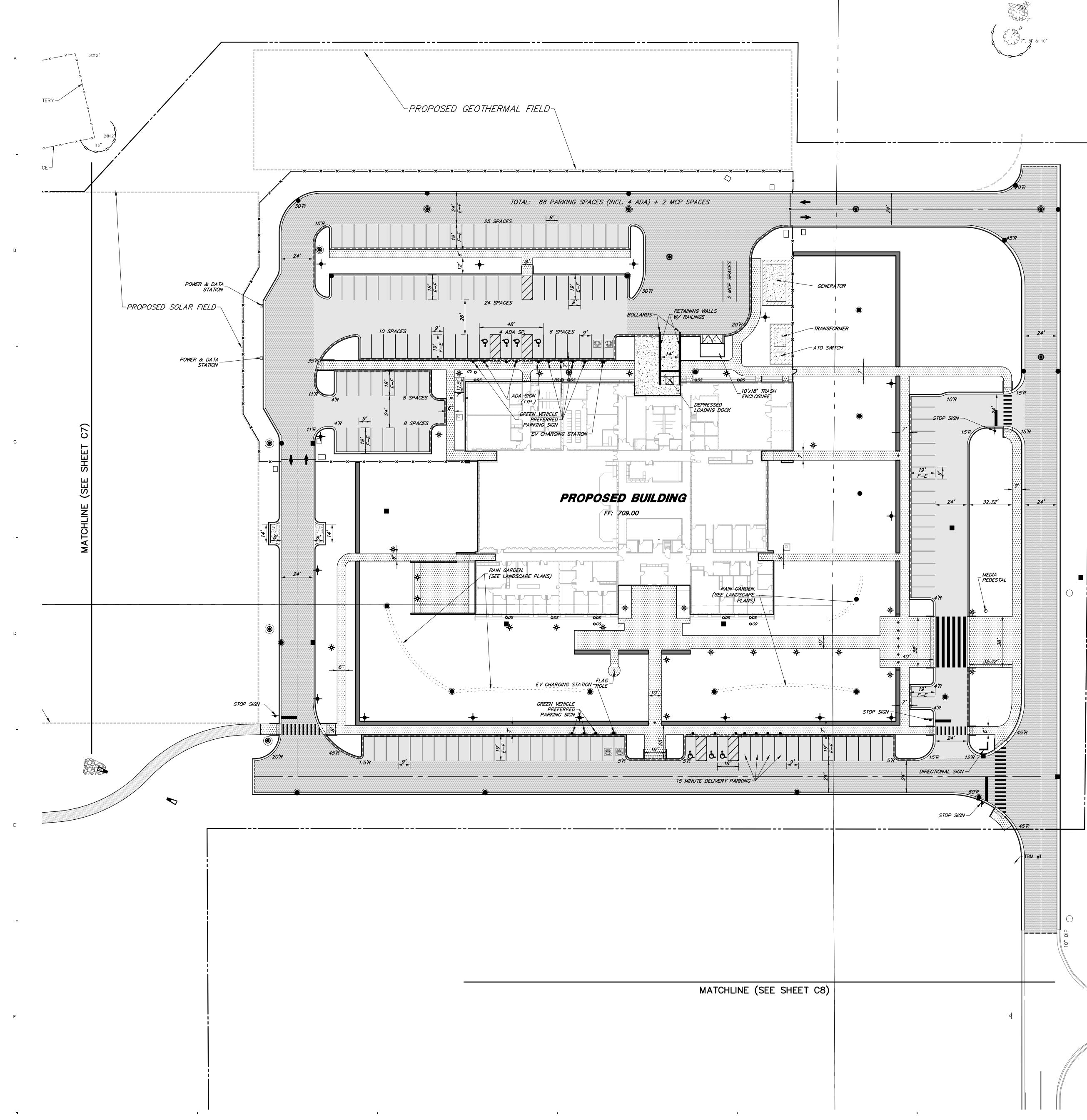
3.10 DEMONSTRATION

- A. Provide (4) hours training (2 sessions) for Owner and maintenance personnel to adjust, operate, and maintain the fire alarm system and equipment. Video tape training session and deliver videotape to Engineer as part of the Closeout Documents. Provide initial 2-hour field training. Provide an additional training session with a manufacturer's field representative 11 months after substantial completion shall be required for a minimum of 2 hours. Refer to Division 01 Section "Demonstration and Training".
- B. Refer to Division 25 20 28.31.11 for BACnet Interface Device commissioning, demonstration and training requirements.
- C. Film training of systems as part of closeout documents. Refer to 01 79 00 Demonstration and Training for specific information.

3.11 CLEANING AND PROTECTION

A. Provide final cleaning and protection and maintain conditions in a manner acceptable to Installer, which ensures system being free from damage and deterioration at time of Substantial Completion.

END OF SECTION 28 31 11



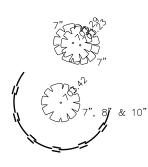
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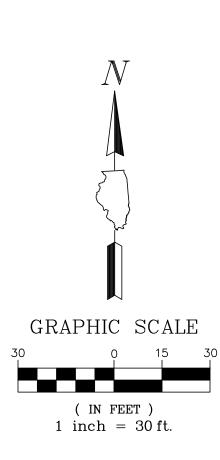


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PROPOSED LEGEND

(HEAVY DUTY BITUMINOUS PAVEMENT					
		NORMAL DUTY BITUMINOUS PAVEMENT					
		PCC PAVEMENT					
		PERMEABLE PAVERS					
		STANDARD PAVERS					
	· · · · · · · · · · · · · · · · · · ·	PCC SIDEWALK					
		HMA PATH					
	* * * * * * * * * * * *	SOD RESTORATION					
		STONE RIP RAP, CLASS A1					
		AGGREGATE					
	000000	DETECTABLE WARNINGS					
		B6.12 CURB & GUTTER (REGULAR)					
	=	B6.12 CURB & GUTTER (DEPRESSED)					
		B6.12 CURB & GUTTER (REVERSE PITCH)					
		PAVEMENT SAWCUT					
	××	FENCE					
	\bigcirc	TREE TRUNK PROTECTION FENCE					
	S	PERIMETER EROSION BARRIER					
	CF	CONSTRUCTION FENCE					
I		RETAINING WALLS					

GEOMETRIC AND PAVING PLAN

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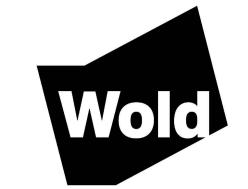
- 1. All pavement dimensions are to edge of pavement, unless otherwise noted. E=edge of pavement, B=back of curb, F=face of curb. Radii dimensions are to back of curb.
- 2. Install all curb and sidewalk as shown. Note some curbs require reverse pitch gutter. Dowel new sidewalk and curb to existing and proposed curbs per general notes. When constructing a carriage walk, the proposed sidewalk contraction and expansion joints shall align with existing curb joints. All concrete sidewalk and curb will have 2 coats of WHITE curing compound applied. Clear curing compound will not be accepted.
- 3. Provide 1.90% cross slope and 4.5% maximum longitudinal slope on all sidewalks and pedestrian path ways unless otherwise indicated. Illinois accessibility code requires a maximum constructed cross slope of 2.00% and longitudinal slope of 5.00%.
- 4. Hot mix Asphalt (HMA) paving After passing proof roll, the contractor shall string line the parking lot with the engineer from all summit points and curb lines with the engineer. Any areas that do not meet minimum pavement cross slope (1.1%) will be corrected, re-compacted and re-proof rolled. Refer to detail sheet for specific pavement sections and general note sheet for construction, testing and compaction requirements.
- 5. Install all 8" PCC pavement, sidewalk and B6.12 curb and gutter per plans and details. Contraction joints shall be sawcut a minimum of 2" deep within 12 hours of pour for all curb and PCC pavement. Sidewalk joints will be tooled and will line up when adjacent to curb. Refer to detail sheet for specific pavement section and general notes for construction, testing and compaction requirements. Refer to Architectural Plans for Loading Dock details.
- 6. All parking lot stall markings shall be 4" Yellow paint and all other parking lot pavement markings shall be paint, color as noted, in accordance with Section 780 of the IDOT Standard Specifications. (Two single applications, 16 mils each required). Site pavement marking shall be coordinated with Site engineer. Contractor shall notify site engineer 48 hrs prior to installing pavement marking.
- 7. For handicapped stall markings, refer to Handicapped Parking Stall and Sign Dimensioning Detail. Stripe EV spaces as shown on details.
- 8. Install new signs and handicapped parking signs using 2" galvanized square tube post and telescoping post sleeve per IDOT standard.
- 9. Install transformer pads as shown. Pad shall be set 4" above finished grade. Refer to MEP plans for final pad size and design requirements.
- 10. Refer to Architectural plans for all fencing details.

ASPHALT

Regional Operations and Communications Facility

Lake County Campus Libertyville, IL 60048

656 Winchester Rd, Libertyville, IL 60048





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Solution

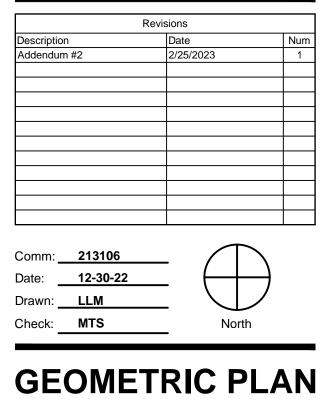
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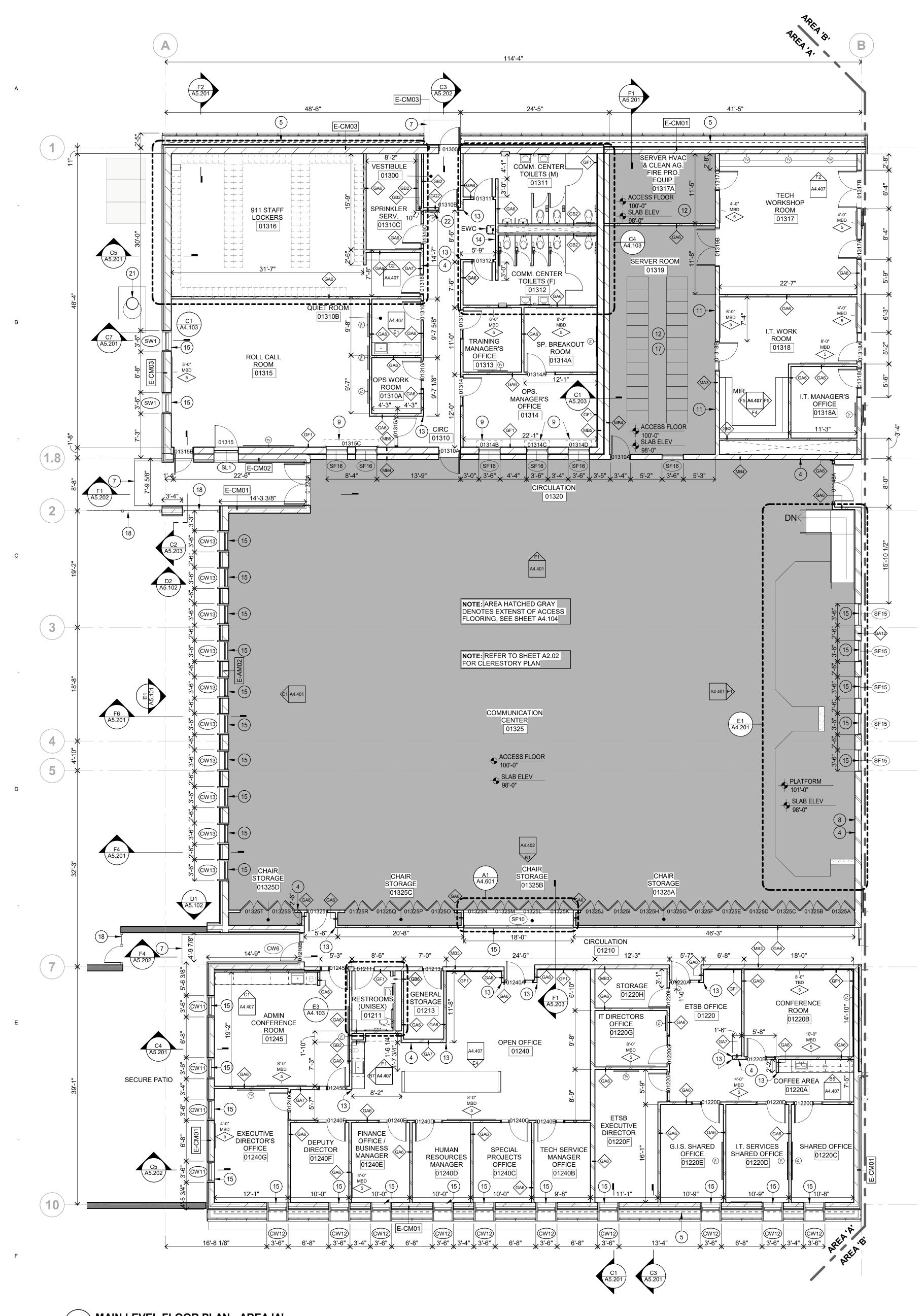
I hereby certify that this plan, specification or report was prepared by me or under my direct supervision and that I am a duly Licensed CIVIL ENGINEER under the laws of the State of Illinois

Gewalt Hamilton Assoc., Inc. License Number: 184.000922-0010 EXPIRES: 11/30/2023



Scale: 1" = 30'





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F1) MAIN LEVEL FLOOR PLAN - AREA 'A'

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PLAN GENERAL NOTES

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- 1. ALL PLAN DIMENSIONS ARE NOMINAL TO FACE OF WALL. WALL THICKNESSES ARE SHOWN NOMINAL, SEE WALL TYPES FOR ACTUAL THICKNESS.
- 2. ALL GYP. WALLS ARE TO BE 5 INCHES THICK UNLESS OTHERWISE NOTED. 3. ALL CONCRETE BLOCK WALLS ARE TO BE 8 INCHES THICK UNLESS
- OTHERWISE NOTED. 4. COORDINATE SIZE AND LOCATION OF ALL DUCT AND SHAFT OPENINGS IN WALLS AND FLOORS W/ MECH. AND ELEC. PROVIDE ALL REQUIRED
- LINTELS FOR OPENINGS. SEE LINTEL SCHEDULE. 5. FIELD VERIFY ALL MILLWORK OPENINGS.
- OTHERWISE NOTED. PROVIDE CONSISTENT SLOPE FROM WALL TO DRAIN BY SLOPING CONCRETE, MIN. 1/4" PER FOOT.
- 7. VERIFY LOCATION, SIZE AND QUANTITY OF ALL MECHANICAL AND ELECTRICAL EQUIPMENT PADS. 8. ALL DOOR/SIDELITE OPENINGS TO BEGIN 4" FROM ADJACENT WALL
- UNLESS OTHERWISE NOTED. 9. ALL GYP. WALLS ARE CENTERED ON GRID UNLESS OTHERWISE NOTED.
- ALL EXPOSED CORNERS SHALL BE BULLNOSE. 10. FIRE RATED WALLS ARE INDICATED ON CODE PLANS.
- 11. PROVIDE BLOCKING AT ALL VISUAL DISPLAY BOARD AND MONITOR LOCATIONS. SEE DETAIL C7 / A4.102
- 12. COORDINATE FINAL LOCATION OF ALL MONITORS WITH OWNER PRIOR TO INSTALLATION.
- 13. CONTRACTOR TO PROVIDE BIM CLASH DETECTION IN ACCORDANCE WITH ALL REQUIREMENTS AS INDICATED IN SPECIFICATION SECTION 01 32 50

ROOM FINISH SCHEDULE GENERAL NOTES

- 2. IF ALL WALLS IN ROOM HAVE THE SAME FINISH, THE "N WALL-TYP" COLUMN WILL BE USED.
- 3. DISCREPANCIES BETWEEN THE ROOM FINISH SCHEDULE AND DRAWINGS SHALL BE REPORTED TO THE ARCHITECT FOR FINISH DETERMINATION. 4. ON WALLS WHICH ARE COVERED WITH MILLWORK AND TACK SURFACES, A
- FINISH SHALL NOT BE APPLIED TO THE WALL BEHIND EXCEPT FOR LOCATIONS WHICH MAY BE EXPOSED (I.E. SPACE BETWEEN MILLWORK AND TACK SURFACE.) CONCRETE BLOCK BEHIND MILLWORK AND MARKERBOARDS TO BE TOOLED. 5. REFER TO MATERIAL FINISH/ COLOR SCHEDULE FOR SPECIFIC FINISH TYPES
- AND COLORS. 6. FOR CEILING MATERIAL WHEN MORE THAN ONE CEILING MATERIAL OCCURS THE CEILING FINISH IS INDICATED THUS: "/".

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					ROOM FINISH SC	HEDULE						
				N	WALL - TYP		E WALL	S WALL		W WALL		REMARKS
OOM NO	ROOM NAME	FLOOR	BASE	MATL FIN		MATL	MATL FIN		FIN	MATL	FIN	
1210	CIRCULATION	LVT-1	VB	GWB	PT 6A	GWB	PT 6A	B BLK-1 / GWB	/ PT 6A	GWB	PT 6A	
211	RESTROOMS (UNISEX)	P TILE-2	P TILE-1	GWB	PT 6A	GWB	P TILE-1	GWB	PT 6A	GWB	PT 6A	6
1213	GENERAL STORAGE	CPT-1	VB	CMU	PT 6A	GWB	PT 6A	GWB	PT 6A	GWB	PT 6A	
220	ETSB OFFICE	CPT-3 / LVT-1	VB	GWB	PT 6A	GWB	PT 6D	GWB	PT 6A	GWB	PT 6A	7
1220A	COFFEE AREA	LVT-1	VB	GWB	PT 6A							2, 3, 7
1220B	CONFERENCE ROOM	CPT-3	VB	GWB	PT 6D	GWB	PT 6A	GWB	PT 6A	GWB	PT 6A	
1220C	SHARED OFFICE	CPT-1	VB	GWB	PT 6A							
1220D	I.T. SERVICES SHARED OFFICE	CPT-1	VB	GWB	PT 6A							
1220E	G.I.S. SHARED OFFICE	CPT-1	VB	GWB	PT 6A							
1220F	ETSB EXECUTIVE DIRECTOR	CPT-1	VB	GWB	PT 6A							
1220G	IT DIRECTORS OFFICE	CPT-1	VB	GWB	PT 6A							
1220H	STORAGE	CPT-1	VB	СМU	PT 6A	GWB	PT 6A	GWB	PT 6A	GWB	PT 6A	
1240	OPEN OFFICE	CPT-3 / LVT-1	VB	GWB	PT 6A	GWB	PT 6D	GWB	PT 6A	GWB	PT 6A	2, 3, 7
1240B	TECH SERVICE MANAGER OFFICE	CPT-1	VB	GWB	PT 6A							
1240C	SPECIAL PROJECTS OFFICE	CPT-1	VB	GWB	PT 6A							
1240D	HUMAN RESOURCES MANAGER	CPT-1	VB	GWB	PT 6A							
1240E	FINANCE OFFICE / BUSINESS MANAGER	CPT-1	VB	GWB	PT 6A							
1240F	DEPUTY DIRECTOR	CPT-1	VB	GWB	PT 6A							
1240G	EXECUTIVE DIRECTOR'S OFFICE	CPT-1	VB	GWB	PT 6A							
1245	ADMIN CONFERENCE ROOM	CPT-3 / LVT-1	VB	GWB	PT 6A	GWB	PT 6A	GWB	PT 6A	GWB	PT 6D	2, 3, 7
1300	VESTIBULE	CPT-4	VB	GWB	PT 6A							
1310	CIRC	LVT-1	VB	GWB	PT 6A	GWB	PT 6A / P TILE-1	GWB	PT 6A	GWB	PT 6A	6
1310A	OPS WORK ROOM	CPT-1	VB	GWB	PT 6A							
1310B	QUIET ROOM	CPT-1	VB	GWB	PT 6A							2, 3
1310C	SPRINKLER SERV.	CPT-1	VB	CMU	PT 6A	GWB	PT 6A	GWB	PT 6A	GWB	PT 6A	
1311	COMM. CENTER TOILETS (M)	P TILE-2	P TILE-1	CMU	P TILE-1	GWB	PT 6A	GWB	P TILE-1	GWB	PT 6A	6
1312	COMM. CENTER TOILETS (F)	P TILE-2	P TILE-1	GWB	P TILE-1	GWB	PT 6A	GWB	P TILE-1	GWB	PT 6A	6
1313	TRAINING MANAGER'S OFFICE	CPT-1	VB	GWB	PT 6A							
1314	OPS. MANAGER'S OFFICE	CPT-1	VB	GWB	PT 6A							
1314A	SP. BREAKOUT ROOM	CPT-1	VB	GWB	PT 6A							
1315	ROLL CALL ROOM	CPT-1	VB	GWB	PT 6A							
1316	911 STAFF LOCKERS	CPT-1	VB	СМU	PT 6A	GWB	PT 6A	GWB	PT 6A	CMU	PT 6A	
1317	TECH WORKSHOP ROOM	POLISHED CONC	VB	CMU	PT 6A	GWB	PT 6A	GWB	PT 6A	CMU	PT 6A	
1317A	SERVER HVAC & CLEAN AG. FIRE PRO. EQUIP.	HPL }	VB	СМU	PT 6A	CMU	PT 6A	GWB	PT 6A	CMU	PT 6A	
1318	I.T. WORK ROOM	ept	VB	GWB	PT 6A	GWB	PT 6A	GWB	PT 6A	CMU	PT 6A	
1318A	I.T. MANAGER'S OFFICE	CPT-1	VB	GWB	PT 6A							
	SERVER ROOM	HPL	VB	GWB	PT 6A	CMU	PT 6A	CMU	PT 6A	CMU	PT 6A	
	CIRCULATION	LVT-1	VB	B BLK-1		GWB	PT 6A			GWB	PT 6A	1
	COMMUNICATION CENTER	CPT-1 / CPT-2	VB	GWB	PT 6A	GWB	PT 6A / PT 6B	GWB	PT 6A	GWB	PT 6A / PT 6B	1, 7
	CHAIR STORAGE	CPT-1	VB	GWB	PT 6A							
	CHAIR STORAGE	CPT-1	VB	GWB	PT 6A							
	CHAIR STORAGE	CPT-1	VB	GWB	PT 6A							
	CHAIR STORAGE	CPT-1	VB	GWB	PT 6A							

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6. SET FLOOR DRAINS 3/4" BELOW FINISHED CONCRETE FLOORS UNLESS

1. SEE INTERIOR MATERIAL FINISH / COLOR SCHEDULE FOR ABBREVIATIONS

ROOM FINISH SCHEDULE REMARKS

1. SEE INTERIOR ELEVATIONS FOR ADDITIONAL FINISH INFORMATION.

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- PROVIDE GYPSUM BOARD SOFFIT ABOVE CASEWORK. (SEE CASEWORK ELEVATIONS AND REFLECTED CEILING PLANS.)
- 3. PROVIDE VINYL BASE AT CASEWORK.
- 4. PAINT CEILING AND ALL EXPOSED STRUCTURE, PIPING, CONDUIT, MECHANICAL DUCTS
- AND VENTS. 5. NOT USED

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- 6. SEE A4.305 FOR TILE PATTERNS.
- 7. SEE FLOOR FINISH PLANS FOR ADDITIONAL FLOORING INSTALLATION INFORMATION.
- 8. PROVIDE FRP PANELS AND TRIM TO 4'-0" AFF AT ALL WALLS WITH PAINT ABOVE.

FLOOR PLAN KEY NOTES:

- (1) DOOR ACTUATORS
- 2) BOLLARD SEE DETAIL 21001.
- 3 MOP SINK SEE MECHANICAL
- 4) FIRE EXTINGUISHER. COORDINATE LOCATION WITH OWNER AND FIRE MARSHALL. (5) DRAIN TILE TO EXTENTS AS INDICATED BY DASHED
- LINE. (6) CABINET UNIT HEATER. SEE DETAIL 43046.
- SEE MECH. FOR SPECIFICATIONS, COORDINATE LOCATION WITH MECH.
- (7) CONCRETE STOOP, ALIGN WITH CENTER OF DOOR U.N.O - SEE STRUCT.
- (8) LOCATION OF SEMI-RECESSED DEFIBRILLATOR CABINET. COORDINATE LOCATION WITH OWNER.
- (9) WALL MOUNTED COILING FIRE/STORM SHUTTER
- (10) SHELF AND MOP HOLDER
- 11) FIRE RATED CONSTRUCTION WALL PANEL. FULL SHEETS MOUNTED VERTICALLY ABOVE WALL BASE -COORDINATE WITH ELEC
- (12) ALL DOORS, WALLS, AND WINDOWS ARE TO BE
- SEALED AIR TIGHT.
- (13) CORNER GAURD, SEE C4/A4.601
- (14) PROVIDE FULL HEIGHT TILE AT INDICATED WALL. SEE B7/A4.305
- (15) MANUAL ROLLER SHADE.

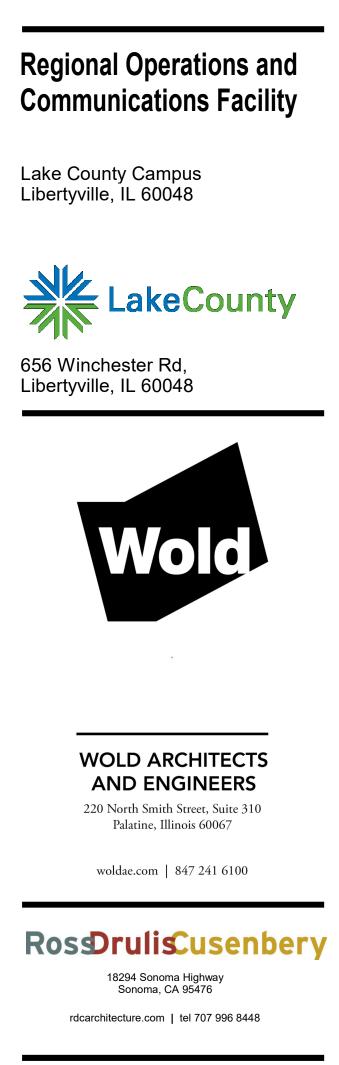
- (16) MOTORIZED ROLLER SHADE, SEE ELEC. & REFERENCE DETAIL F5/A4.903 (17) SEE MAIN LEVEL ACCESS FLOOR PLAN FOR
- ADDITIONAL DETAIL
- (18) ORNAMENTAL METAL FENCE SEE ARCH SITE PLAN

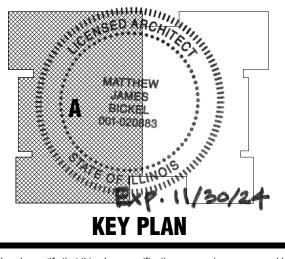
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(19) INTERCOM KIOSK

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- (20) NEW AUXCOM TOWER REFER TO SHEET R2.02
- (21) NEW 911 TOWER REFER TO SHEET R2.01
- (22) WALL MOUNTED MONITOR. PROVIDED BLOCKING AS TYPICAL. VERIFY FINAL HEIGHT WITH OWNER





I hereby certify that this plan, specification or report was prepared by me or under my direct supervision and that I am a duly Licensed ARCHITECT under the laws of the State of Illinois

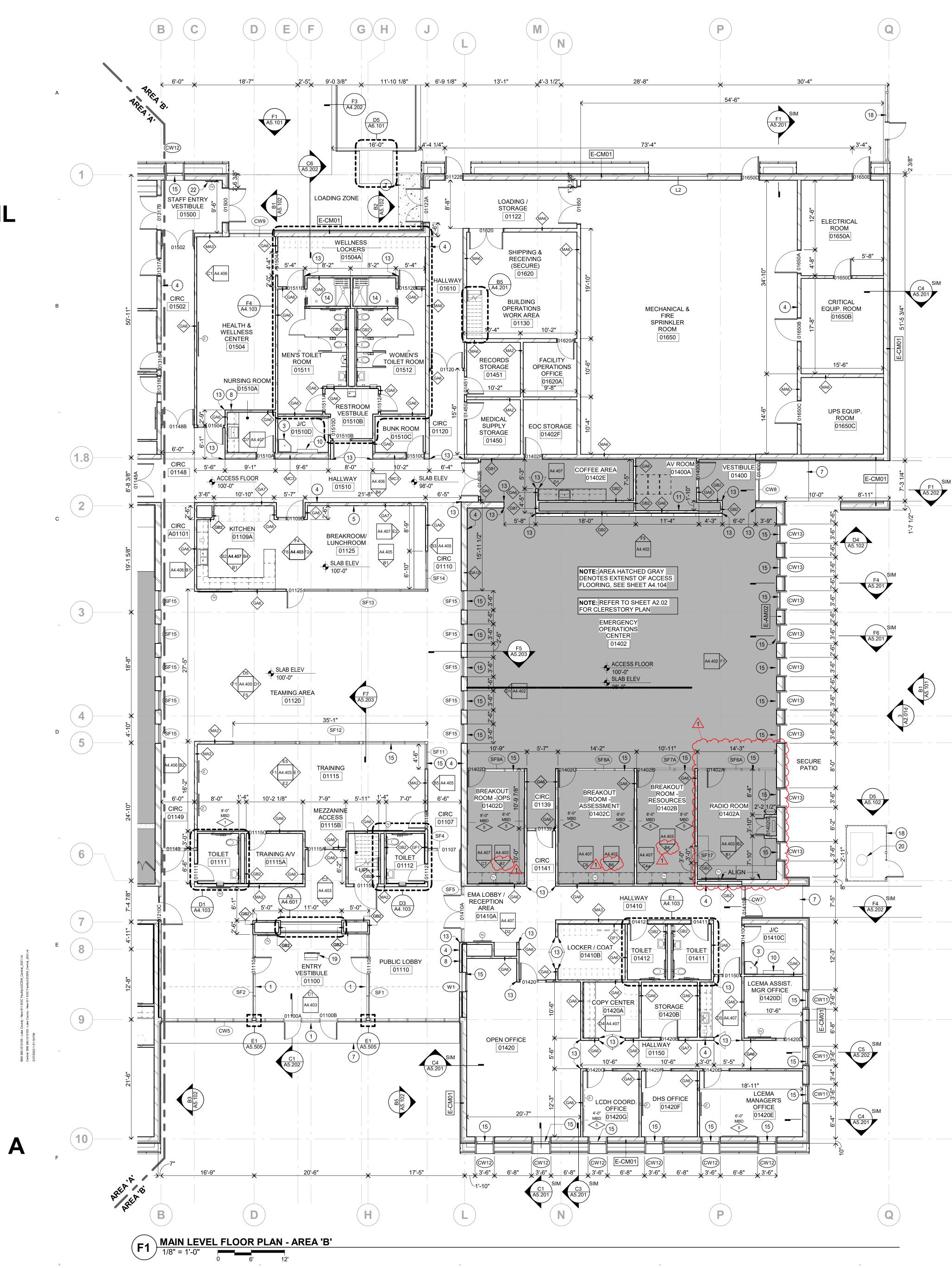
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nse Number:	Matthew 5 001.020883		11/30/	2024							

Revi	sions	
Description	Date	Num
Addendum #2	02/24/2023	1
Comm: 213106	-	

Date: 12/30/2022 Check: **KM**I FLOOR PLAN -

AREA 'A'





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PLAN GENERAL NOTES

I.

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- THICKNESS. OTHERWISE NOTED. LINTELS FOR OPENINGS. SEE LINTEL SCHEDULE. FIELD VERIFY ALL MILLWORK OPENINGS. BY SLOPING CONCRETE, MIN. 1/4" PER FOOT. ELECTRICAL EQUIPMENT PADS. UNLESS OTHERWISE NOTED. 9. ALL GYP. WALLS ARE CENTERED ON GRID UNLESS OTHERWISE NOTED. ALL EXPOSED CORNERS SHALL BE BULLNOSE. 10. FIRE RATED WALLS ARE INDICATED ON CODE PLANS. 11. PROVIDE BLOCKING AT ALL VISUAL DISPLAY BOARD AND MONITOR LOCATIONS. SEE DETAIL C7 / A4.102

INSTALLATION.

- ROOM FINISH SCHEDULE GENERAL NOTES
- WILL BE USED.
- MARKERBOARDS TO BE TOOLED. AND COLORS. THE CEILING FINISH IS INDICATED THUS: "/".

ROOM NO ROOM NAME 01100 ENTRY VESTIBULE 01107 CIRC 01109A KITCHEN PUBLIC LOBBY 01110 CIRC TOILET)1112 TOILET)1115 TRAINING 01115A TRAINING A/V 01115B MEZZANINE ACCESS 1120 TEAMING AREA CIRC LOADING / STORAGE BREAKROOM/ LUNCH BUILDING OPERATIC CIRC 01139 01141 CIRC 01148 CIRC 01149 CIRC 01150 HALLWAY 01400 VESTIBULE 01400A AV ROOM 01402 EMERGENCY OPERA 01402A RADIO ROOM 01402B BREAKOUT ROOM - F 01402C BREAKOUT ROOM - / 01402D BREAKOUT ROOM -01402E COFFEE AREA 01402F EOC STORAGE 01410 HALLWAY 01410A EMA LOBBY / RECEPT 01410B LOCKER / COAT 01410C J/C 01411 TOILET 01412 TOILET 01420 OPEN OFFICE 01420A COPY CENTER 01420B STORAGE 01420D LCEMA ASSIST. MGR 01420E LCEMA MANAGER'S D1420F DHS OFFICE 1420G LCDH COORD. OFFI 01450 MEDICAL SUPPLY S RECORDS STORAGE)1451 01500 STAFF ENTRY VESTI 01502 CIRC 1504 HEALTH & WELLNESS 01504A WELLNESS LOCKER 01510 HALLWAY 1510A NURSING ROOM 1510B RESTROOM VESTBU 1510C BUNK ROOM 1510D J/C MEN'S TOILET ROOM 01512 WOMEN'S TOILET RO 01610 HALLWAY

01620 SHIPPING & RECEIVI 1620A FACILITY OPERATIO MECHANICAL & FIRE D1650A ELECTRICAL ROOM 01650B CRITICAL EQUIP. ROO 01650C UPS EQUIP. ROOM

I.

POLISHED CONC VB

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I.

PT 6A

1. ALL PLAN DIMENSIONS ARE NOMINAL TO FACE OF WALL. WALL THICKNESSES ARE SHOWN NOMINAL, SEE WALL TYPES FOR ACTUAL

2. ALL GYP. WALLS ARE TO BE 5 INCHES THICK UNLESS OTHERWISE NOTED. 3. ALL CONCRETE BLOCK WALLS ARE TO BE 8 INCHES THICK UNLESS

6

4. COORDINATE SIZE AND LOCATION OF ALL DUCT AND SHAFT OPENINGS IN WALLS AND FLOORS W/ MECH. AND ELEC. PROVIDE ALL REQUIRED

SET FLOOR DRAINS 3/4" BELOW FINISHED CONCRETE FLOORS UNLESS OTHERWISE NOTED. PROVIDE CONSISTENT SLOPE FROM WALL TO DRAIN 7. VERIFY LOCATION, SIZE AND QUANTITY OF ALL MECHANICAL AND

8. ALL DOOR/SIDELITE OPENINGS TO BEGIN 4" FROM ADJACENT WALL

12. COORDINATE FINAL LOCATION OF ALL MONITORS WITH OWNER PRIOR TO

13. CONTRACTOR TO PROVIDE BIM CLASH DETECTION IN ACCORDANCE WITH ALL REQUIREMENTS AS INDICATED IN SPECIFICATION SECTION 01 32 50

1. SEE INTERIOR MATERIAL FINISH / COLOR SCHEDULE FOR ABBREVIATIONS 2. IF ALL WALLS IN ROOM HAVE THE SAME FINISH, THE "N WALL-TYP" COLUMN

DISCREPANCIES BETWEEN THE ROOM FINISH SCHEDULE AND DRAWINGS SHALL BE REPORTED TO THE ARCHITECT FOR FINISH DETERMINATION. ON WALLS WHICH ARE COVERED WITH MILLWORK AND TACK SURFACES, A FINISH SHALL NOT BE APPLIED TO THE WALL BEHIND EXCEPT FOR LOCATIONS WHICH MAY BE EXPOSED (I.E. SPACE BETWEEN MILLWORK AND TACK SURFACE.) CONCRETE BLOCK BEHIND MILLWORK AND

REFER TO MATERIAL FINISH/ COLOR SCHEDULE FOR SPECIFIC FINISH TYPES FOR CEILING MATERIAL WHEN MORE THAN ONE CEILING MATERIAL OCCURS 1. SEE INTERIOR ELEVATIONS FOR ADDITIONAL FINISH INFORMATION.

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- 2. PROVIDE GYPSUM BOARD SOFFIT ABOVE CASEWORK. (SEE CASEWORK ELEVATIONS AND REFLECTED CEILING PLANS.)
- 3. PROVIDE VINYL BASE AT CASEWORK.
- 4. PAINT CEILING AND ALL EXPOSED STRUCTURE, PIPING, CONDUIT, MECHANICAL DUCTS AND VENTS.

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5. NOT USED

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- 6. SEE A4.305 FOR TILE PATTERNS.
- 7. SEE FLOOR FINISH PLANS FOR ADDITIONAL FLOORING INSTALLATION INFORMATION.
- 8. PROVIDE FRP PANELS AND TRIM TO 4'-0" AFF AT ALL WALLS WITH PAINT ABOVE

FLOOR PLAN KEY NOTES:

- (1) DOOR ACTUATORS
- 2) BOLLARD SEE DETAIL 21001. 3) MOP SINK - SEE MECHANICAL
- 4) FIRE EXTINGUISHER. COORDINATE LOCATION WITH
- OWNER AND FIRE MARSHALL) DRAIN TILE TO EXTENTS AS INDICATED BY DASHED
- LINE. (6) CABINET UNIT HEATER. SEE DETAIL 43046.
- SEE MECH. FOR SPECIFICATIONS, COORDINATE
- LOCATION WITH MECH. 7 CONCRETE STOOP, ALIGN WITH CENTER OF DOOR
- U.N.O SEE STRUCT. (8) LOCATION OF SEMI-RECESSED DEFIBRILLATOR
- CABINET. COORDINATE LOCATION WITH OWNER. (9) WALL MOUNTED COILING FIRE/STORM SHUTTER
- 10) SHELF AND MOP HOLDER) FIRE RATED CONSTRUCTION WALL PANEL. FULL
- SHEETS MOUNTED VERTICALLY ABOVE WALL BASE -COORDINATE WITH ELEC
- (12) ALL DOORS, WALLS, AND WINDOWS ARE TO BE
- SEALED AIR TIGHT. (13) CORNER GAURD, SEE C4/A4.601
- (14) PROVIDE FULL HEIGHT TILE AT INDICATED WALL. SEE
- B7/A4.305 (15) MANUAL ROLLER SHADE.

- (16) MOTORIZED ROLLER SHADE, SEE ELEC. & **REFERENCE DETAIL F5/A4.903**
- (17) SEE MAIN LEVEL ACCESS FLOOR PLAN FOR ADDITIONAL DETAIL
- (18) ORNAMENTAL METAL FENCE SEE ARCH SITE PLAN

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- (19) INTERCOM KIOSK
- (20) NEW AUXCOM TOWER REFER TO SHEET R2.02
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- (22) WALL MOUNTED MONITOR. PROVIDED BLOCKING AS TYPICAL. VERIFY FINAL HEIGHT WITH OWNER

				ROOM FINISH	I SCHEDULE						
		N WALL - TYP				E WALL S WALL			W	' WALL	
	FLOOR	BASE	MATL	FIN	MATL	FIN	MATL	FIN	MATL	FIN	REMARKS
											- <u>I</u> .
			GWB	WD-1							1
	CPT-2	VB			GWB	PT 6C	GWB	PT 6A	GWB / CMU	PT 6C / WD-1	1
	LVT-1	VB	GWB	PT 6A / WD-1			GWB	WD-1	GWB	WD-1	1, 2, 3
	LVT-1	VB	GWB / B BLK-1	PT 6A / WD-1/	GWB	PT 6A	/ GWB	WD-1	GWB	PT 6A	1
	CPT-2	VB			GWB	PT 6C			GWB	PT 6C / WD-1	1
			GWB	PT 6A	GWB	P TILE-1	GWB	PT 6A PT 6A	GWB	PT 6A	6
	P TILE-2 CPT-1 / CPT-2	VB	GWB CMU	PT 6A WD-1	GWB CMU	PT 6A WD-1	GWB GWB	PT 6A / PT 6B	GWB CMU	P TILE-1 WD-1	6
	CPT-1/CPT-2	VB	GWB	PT 6A	CINIO	VVD-1	GVVD	PIOA/PIOD		VV D-1	1
3	CPT-1	VB	GWB	PT 6A							
)	CPT-1 / CPT-2	VB	GWB	PT 6C / WD-1	GWB	PT 6A / PT 6C	CMU / GWB	PT 6C / WD-1	GWB	PT 6A / PT 6C	1
	LVT-1	VB	GWB	PT 6A	000				OV D		
	POLISHED CONC		СМИ	PT 6A							
- HROOM	LVT-1	VB	GWB	WC-1	GWB	WD-1	GWB	WD-1			1
NS WORK AREA	POLISHED CONC		CMU	PT 6A	0.10						
	CPT-1	VB	GWB	PT 6A							
	LVT-1	VB	GWB	PT 6A							
	LVT-1	VB	GWB	PT 6A							
	CPT-2	VB			GWB / CMU	PT 6C / WD-1	GWB	PT 6A	GWB	PT 6C	1
	CPT-3	VB	GWB	PT 6A							
	CPT-4	VB	GWB	PT 6A							
	CPT-1	VB	GWB	PT 6A							
TIONS CENTER	CPT-1 / CPT-2	VB	GWB	PT 6A	GWB	PT 6B	GWB	PT 6A	GWB	PT 6B	1, 7
	CPT-1	VB	GWB	PT 6A							
RESOURCES	CPT-1	VB	GWB	PT 6A							3
ASSESSMENT	CPT-1	VB	GWB	PT 6A							3
OPS	CPT-1	VB	GWB	PT 6A							3
	LVT-1	VB	GWB	PT 6A							2, 3
	POLISHED CONC	VB	CMU	PT 6A							
	LVT-1	VB	GWB	PT 6A	GWB	PT 6A	B BLK-1 / GWB	/ PT 6A			
TION AREA	LVT-1	VB	GWB	PT 6A							
	CPT-1	VB	GWB	PT 6A							
	POLISHED CONC		CMU	PT 6A	CMU	PT 6A		PT 6A	GWB	PT 6A	8
		P TILE-1	GWB	PT 6A	GWB	PT 6A	GWB	PT 6A	GWB	P TILE-1	6
		P TILE-1	GWB	PT 6A	GWB	P TILE-1	GWB	PT 6A	GWB	PT 6A	6
	CPT-3	VB	GWB	PT 6A	GWB	PT 6A	GWB	PT 6D	GWB	PT 6A	
	CPT-1	VB	GWB	PT 6A							
	CPT-1	VB	GWB	PT 6A							
OFFICE	CPT-1	VB	GWB	PT 6A							
OFFICE	CPT-1	VB	GWB	PT 6A							
	CPT-1	VB	GWB	PT 6A							
	CPT-1	VB	GWB	PT 6A			CMU .	DT CA		DT CA	
ORAGE	POLISHED CONC		CMU	PT 6A	CMU	PT 6A	CMU	PT 6A PT 6A	GWB	PT 6A	
BULE	POLISHED CONC CPT-4	VB VB	CMU GWB	PT 6A PT 6A	CMU	PT 6A	CMU	IT UA	GWB	PT 6A	
DULE	LVT-1	VB VB	GWB	PT 6A PT 6A							
S CENTER	RAF-1	VB VB	GWB	PT 6A	GWB	WC-2	GWB	PT 6A	GWB	PT 6A	1
S CENTER	CPT-3	VB VB	GWB	PT6A PT6A	GVVD	100-2	GVVD		500	FTUA	1
<i>,</i>	LVT-1	VB	GWB	PT6A							
	CPT-1	VB VB	GWB	PT 6A							2, 3
E	LVT-1	VB	GWB	P TILE-1	GWB	PT 6A	GWB	PT 6A	GWB	PT 6A	6
	CPT-1	VB	GWB	PT 6A	500						
	POLISHED CONC		GWB	PT 6A							8
			GWB	PT 6A	GWB	P TILE-1	GWB	PT 6A	GWB	PT 6A	6
OM			GWB	PT 6A	GWB	PT 6A	GWB	PT 6A	GWB	P TILE-1	6
	POLISHED CONC				GWB / CMU	PT 6A	GWB	PT 6A	CMU	PT 6A	-
NG (SECURE)	POLISHED CONC		СМИ	PT 6A							
NS OFFICE	POLISHED CONC		СМИ	PT 6A							
SPRINKLER ROOM	POLISHED CONC		СМИ	PT 6A							
	POLISHED CONC		СМО	PT 6A							
OM	POLISHED CONC		СМИ	PT 6A							
			CMU	DT 6A							

Regional Operations and Communications Facility

Lake County Campus Libertyville, IL 60048

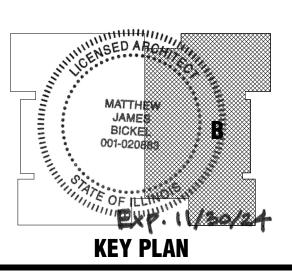




WOLD ARCHITECTS AND ENGINEERS 220 North Smith Street, Suite 310 Palatine, Illinois 60067

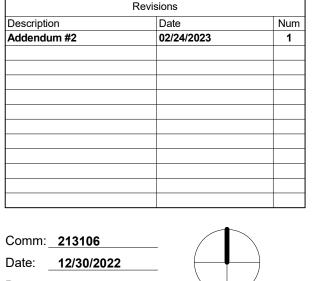
woldae.com | 847 241 6100





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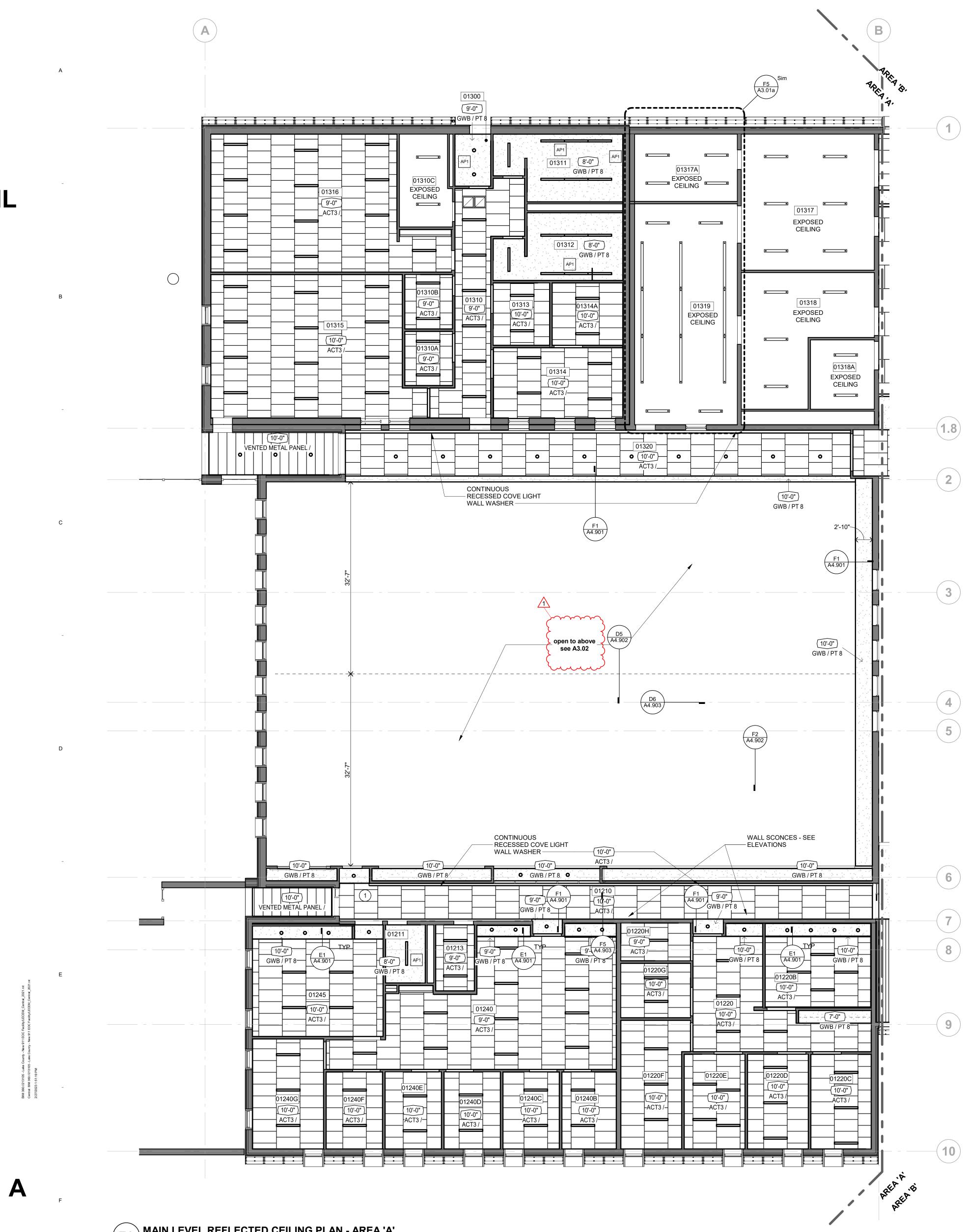




Drawn: JMK / MB Check: KME FLOOR PLAN AREA 'B'

Scale: As indicated





MAIN LEVEL REFLECTED CEILING PLAN - AREA 'A'

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RCP GENERAL NOTES

- 2 PLANS 4. FOR LIGHT FIXTURE TYPES, SEE ELECTRICAL LIGHTING PLANS
- INSTALLATION PAINTING NOTES

RCP KEY NOTES:

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1. ALL ACCESS PANELS TO BE COORDINATED WITH MECH/PLUMBING ACCESS PRIOR TO INSTALL.

SPRINKLER HEADS ARE NOT SHOWN. LOCATE ALL SPRINKLER HEADS IN THE CENTER OF CEILING TILES. 3. FOR DIFFUSER AND RETURN GRILL SIZES, SEE MECHANICAL

5. CEILING HEIGHTS INDICATED ON PLAN (I.E. 9'-0") ARE FROM FINISHED FLOOR OF LEVEL OF PLAN SHOWN OR AS INDICATED 6. VERIFY GYP. BD. CONTROL JOINTS WITH ARCHITECT PRIOR TO

7. SEE CASEWORK ELEVATIONS FOR ADDITIONAL SOFFIT

(1) CABINET UNIT HEATER, COORDINATE WITH MECH.

2 ALL CONTRACTORS TO COORDINATE EQUIPMENT/UTILITY HEIGHTS AND LOCATIONS PRIOR TO INSTALLATION.

(3) HINGED FABRIC ACCESS DROP PANEL INTERATED INTO FABRIC CEILING FRAMING

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AIR DIFFUSER EXHAUST GRILLE ACCESS PANEL

CANLIGHT

1 X 4 LIGHT FIXTURE

4' STRIP LIGHT FIXTURE

8' STRIP LIGHT FIXTURE

2 X 2 LIGHT FIXTURE

(IN CEILING GRID)

2 X 4 LIGHT FIXTURE

(IN CEILING GRID)

CEILING MOUNTED

LIGHT FIXTURE

AIR DIFFUSER

(IN CEILING GRID)

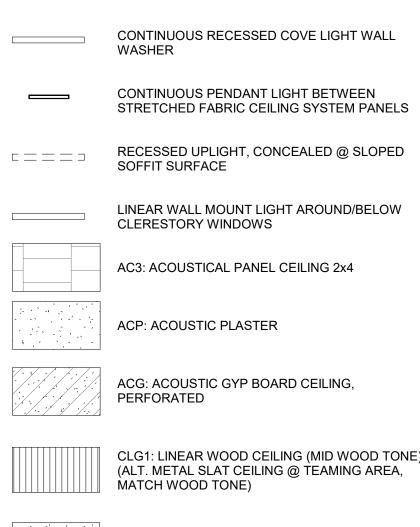
RETURN AIR GRILLE

(IN CEILING GRID)

SPEAKER

7

LINEAR DIFFUSER (IN CEILING GRID) PTD. GYPSUM BOARD **CEILING / SOFFIT** PENDANT LIGHT FIXTURE



I.

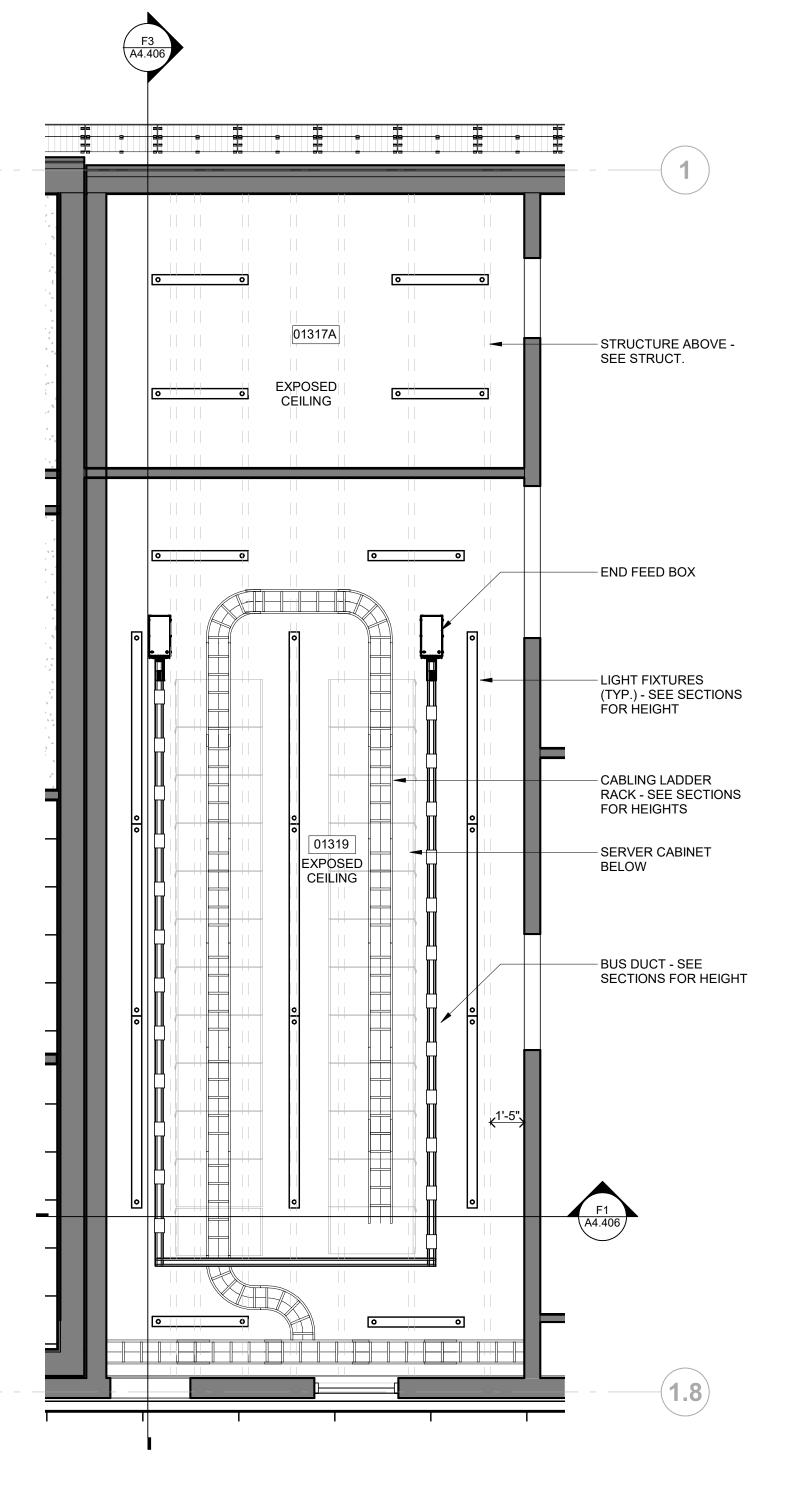
CLG1: LINEAR WOOD CEILING (MID WOOD TONE) (ALT. METAL SLAT CEILING @ TEAMING AREA, MATCH WOOD TONE)

8

4' LINEAR RECCESSED LIGHT FIXTURE

6' PENDANT UP/DOWN LIGHT

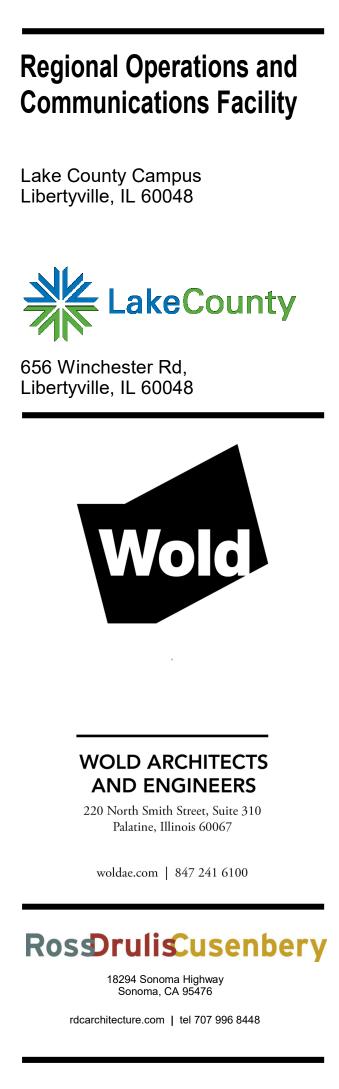
CLG2: STRETCHED FABRIC CEILING SYSTEM

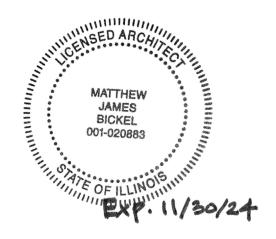


(F5) ENLARGED REFLECTED CEILING PLAN - SERVER ROOM

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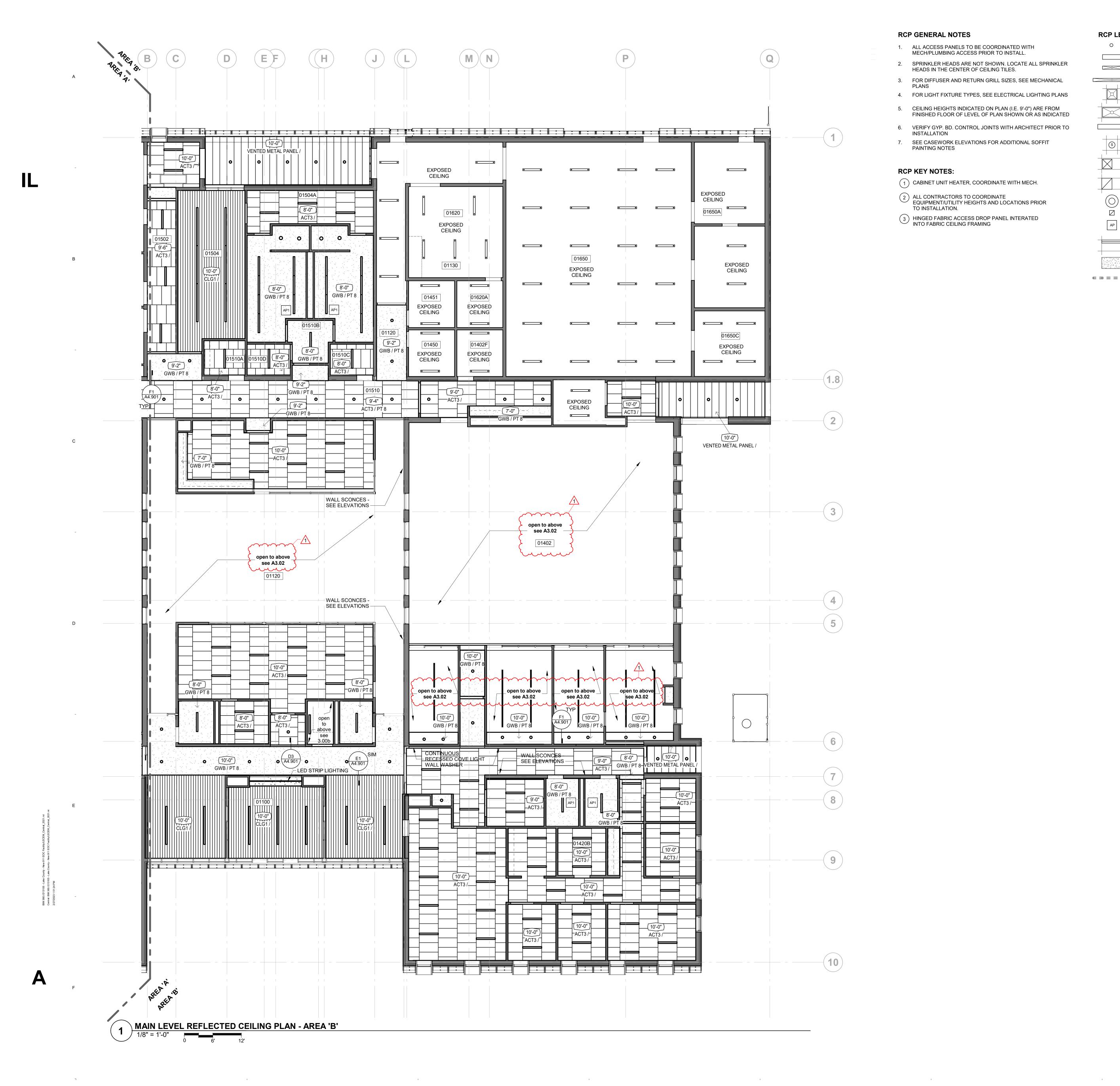
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Matthew **J** Bickel License Number: 001.020883 Date 11/30/2024

F	Revisions	
Description	Date	Num
Addendum #2	02/24/2023	1
	_	
Comm: 213106	_	
Date: 12/30/2022		

Drawn: ML Check: JMK REFLECTED **CEILING PLAN -**AREA 'A'





RCP GENERAL NOTES

- PLANS

- INSTALLATION PAINTING NOTES

RCP KEY NOTES:

- TO INSTALLATION.
- INTO FABRIC CEILING FRAMING

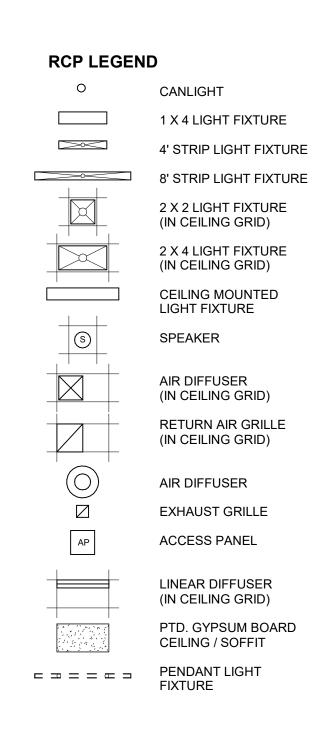
1 <u>5</u> 6 I.

1. ALL ACCESS PANELS TO BE COORDINATED WITH MECH/PLUMBING ACCESS PRIOR TO INSTALL. SPRINKLER HEADS ARE NOT SHOWN. LOCATE ALL SPRINKLER HEADS IN THE CENTER OF CEILING TILES. 3. FOR DIFFUSER AND RETURN GRILL SIZES, SEE MECHANICAL 4. FOR LIGHT FIXTURE TYPES, SEE ELECTRICAL LIGHTING PLANS 5. CEILING HEIGHTS INDICATED ON PLAN (I.E. 9'-0") ARE FROM FINISHED FLOOR OF LEVEL OF PLAN SHOWN OR AS INDICATED 6. VERIFY GYP. BD. CONTROL JOINTS WITH ARCHITECT PRIOR TO 7. SEE CASEWORK ELEVATIONS FOR ADDITIONAL SOFFIT

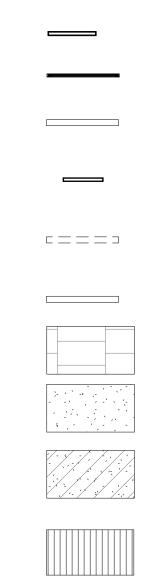
(1) CABINET UNIT HEATER, COORDINATE WITH MECH.

2 ALL CONTRACTORS TO COORDINATE EQUIPMENT/UTILITY HEIGHTS AND LOCATIONS PRIOR

(3) HINGED FABRIC ACCESS DROP PANEL INTERATED



7



I.

4' LINEAR RECCESSED LIGHT FIXTURE 6' PENDANT UP/DOWN LIGHT

CONTINUOUS RECESSED COVE LIGHT WALL WASHER

8

CONTINUOUS PENDANT LIGHT BETWEEN STRETCHED FABRIC CEILING SYSTEM PANELS

RECESSED UPLIGHT, CONCEALED @ SLOPED SOFFIT SURFACE

LINEAR WALL MOUNT LIGHT AROUND/BELOW CLERESTORY WINDOWS

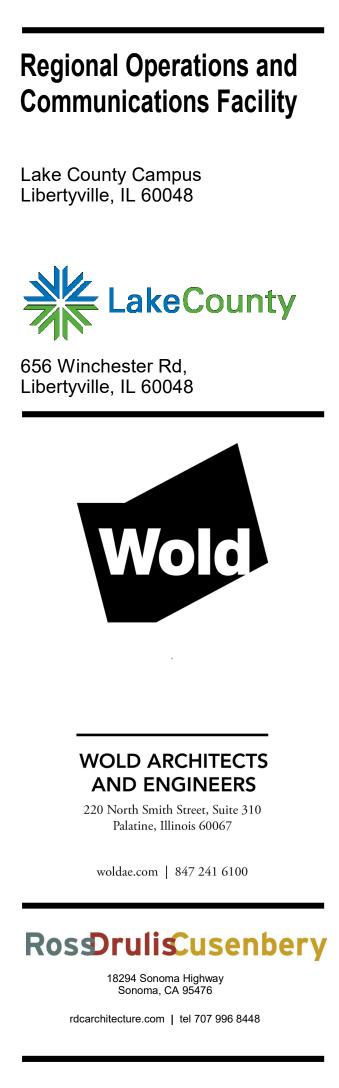
AC3: ACOUSTICAL PANEL CEILING 2x4

ACP: ACOUSTIC PLASTER

ACG: ACOUSTIC GYP BOARD CEILING, PERFORATED

CLG1: LINEAR WOOD CEILING (MID WOOD TONE) (ALT. METAL SLAT CEILING @ TEAMING AREA, MATCH WOOD TONE)

CLG2: STRETCHED FABRIC CEILING SYSTEM





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	Matthew J	Bickel		
nse Number:	001.020883	Date	11/30/2024	

	Revisions	
Description	Date	Num
Addendum #2	02/24/2023	1
Comm: 213106		

Date: 12/30/2022 Drawn: <u>ML</u> Check: JMK







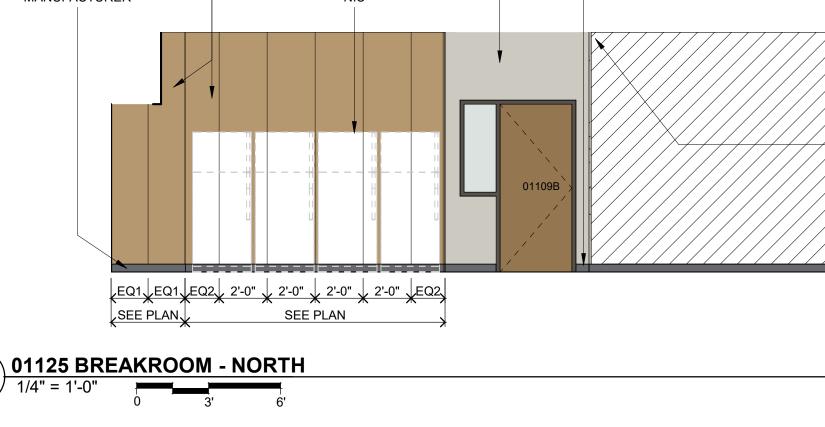
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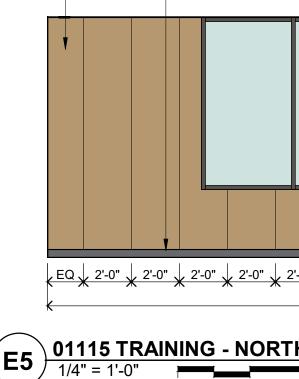
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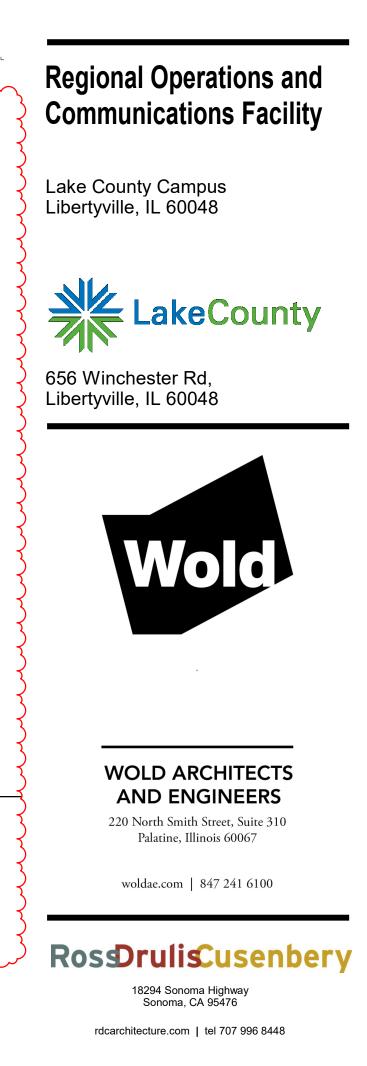


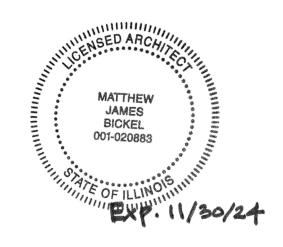
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Mat License Number: 001.0	tthew J Bickel 20883 Date 11/30/20	24
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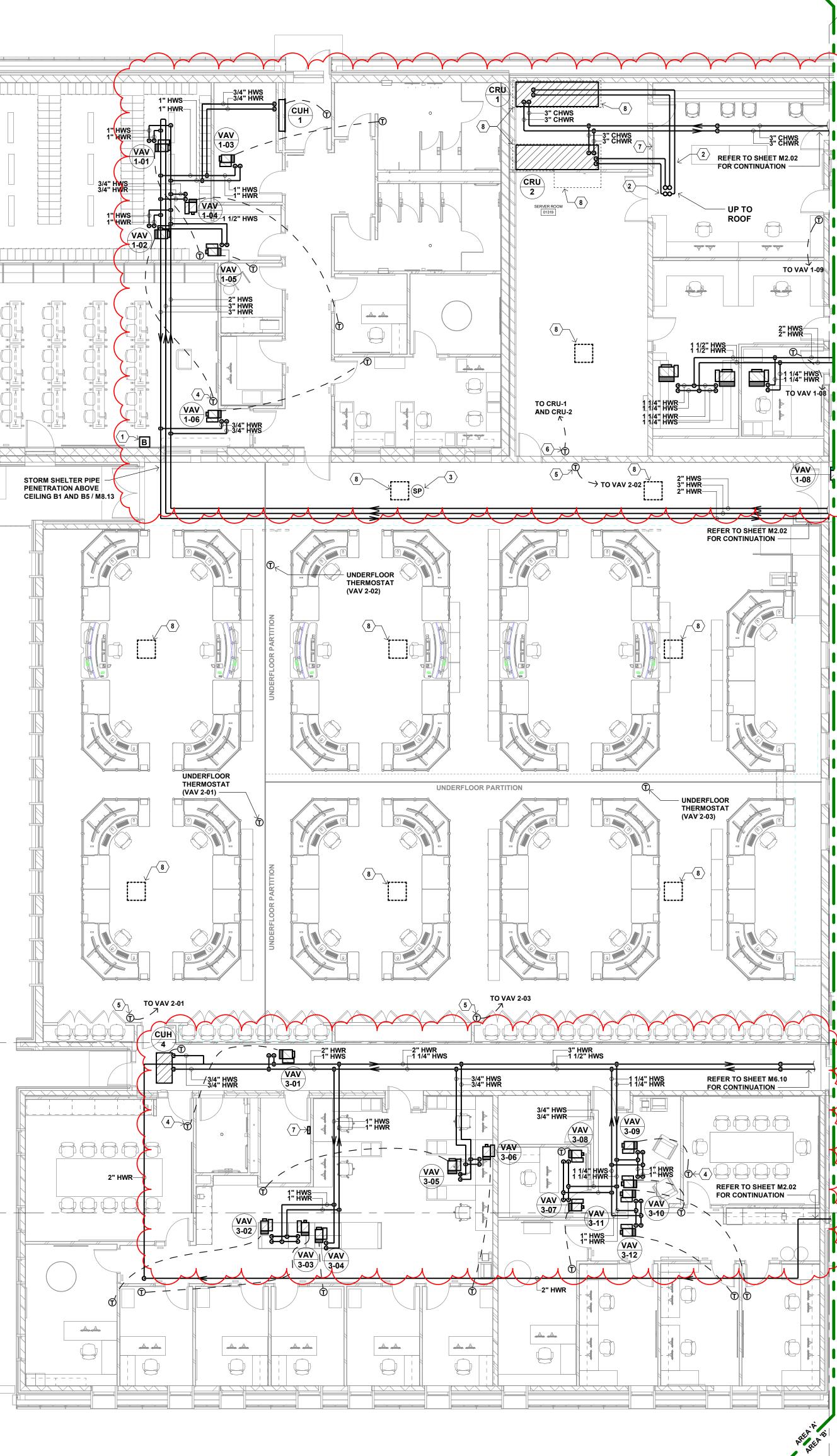
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F2 HYDRONIC & BAS PLAN- AREA 'A'

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HYDRONIC PLAN GENERAL NOTES:

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CONSTRUCTION.

1. ALL RISES AND DROPS IN PIPING ARE NOT NECESSARILY SHOWN. LAYOUT ROUTING AND COORDINATE WORK WITH OTHER TRADES BEFORE

8

2. MECHANICAL CONTRACTOR SHALL BE RESPONSIBLE FOR CUTTING AND PATCHING OF CONSTRUCTION UNLESS OTHERWISE NOTED ON THE PLANS. NO CUTTING OF STRUCTURAL MEMBERS OR STRUCTURE WHICH WILL DETERIORATE THE INTEGRITY AND STRENGTH OF THE BUILDING WILL BE ALLOWED WITHOUT WRITTEN

APPROVAL FROM THE STRUCTURAL ENGINEER. 3. LOCATE ALL VALVES, METERS, GAUGES, AND PIPING SPECIALTIES ABOVE ACCESSIBLE CEILINGS.

4. COORDINATE TEMPERATURE SENSOR LOCATIONS WITH OTHER TRADES, BUILDING ELEMENTS, AND ELECTRICAL SWITCHES. ADJUST THE EXACT LOCATIONS AS REQUIRED TO AVOID CONFLICTS.

5. BRANCH PIPING TO EQUIPMENT TO BE 3/4" UNLESS OTHERWISE NOTED.

6. ROUTE PIPES BETWEEN JOIST WEBS WHERE REQUIRED TO COORDINATE WITH THE INSTALLATION OF OTHER TRADES AND TO MAINTAIN CEILING HEIGHTS. COORDINATE LOCATIONS PRIOR TO CROSS BRACING TO ENSURE THERE ARE NO CONFLICTS.

7. THE MECHANICAL CONTRACTOR SHALL BE RESPONSIBLE FOR ALL REQUIRED REINFORCEMENT OF NEW AND EXISTING STRUCTURAL MEMBERS FOR MECHANICAL SYSTEMS. REFER TO "MECHANICAL SUPPORT REINFORCEMENT DETAIL" FOR ADDITIONAL REQUIREMENTS.

8. REFER TO M9.10, E5.01, AND E5.02 FOR THE BUILDING ENERGY METERING MATRIX AND RISER DIAGRAM.

9. CONTRACTOR TO PROVIDE BIM CLASH DETECTION IN ACCORDANCE WITH ALL REQUIREMENTS AS INDICATED IN SPECIFICATION SECTION 01 32 50.

HYDRONIC PLAN KEYED NOTES: $\langle 1 \rangle$ NATURAL VENTILATION STORM MODE

- PUSHBUTTON.
- 2 PROVIDE REFRIGERANT PIPING AND SIZE IN ACCORDANCE WITH MANUFACTURER'S GUIDELINES.
- (3) LOCATE HIGH SIDE OF SPACE STATIC PRESSURE SENSOR IN CORRIDOR CEILING IN THIS APPROXIMATE LOCATION.
- $\langle 4 \rangle$ COMBINATION TEMPERATURE AND CO2 SENSOR.
- $\langle 5 \rangle$ COMBINATION TEMPERATURE, CO2, AND RH SENSOR.
- $\langle \mathbf{6} \rangle$ COMBINATION TEMPERATURE AND RH SENSOR.

T BACnet BAS IP PANEL. COORDINATE FINAL LOCATION WITH DIV. 23/25/26/27 CONTRACTORS.

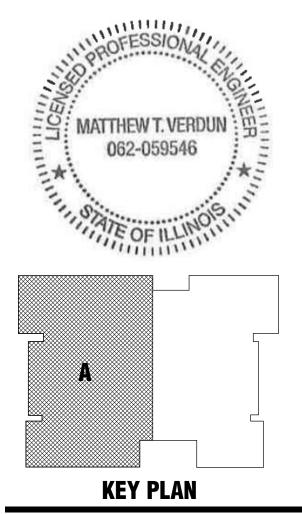
- (8)INSTALL LIQUID DETECTION CABLE AROUND
FLOOR DEPRESSIONS AND CRAC UNIT DRAIN PANS
UNDER THE RAISED FLOOR. REFER TO 23 09 00 FOR SPECIFICATIONS.
- $\langle 9 \rangle$ HEATING WATER BYPASS VALVE
- $\langle 10 \rangle$ CHILLED WATER BYPASS VALVE

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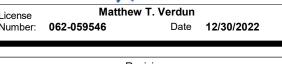






I hereby certify that this plan, specification or report was prepared by me or under my direct supervision and that I am a duly Licensed PROFESSIONAL ENGINEER under the laws of the State of ILLINOIS





F	Revisions	
Description	Date	Num
Addendum #2	02/24/23	1
Comm: <u>213106</u>		
Date: 12/30/2022)
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Scale: 1/8" = 1'-0"



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- REFER TO SHEET M2.01

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TO VAV 1-07

- REFER TO SHEET M2.01 FOR CONTINUATION

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(C)

3/4" HWS-3/4" HWR-

3/4" HWS-3/4" HWR-

3/4" HWS-3/4" HWR-

VAV 1-08

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HYDRONIC PLAN GENERAL NOTES:

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1. ALL RISES AND DROPS IN PIPING ARE NOT NECESSARILY SHOWN. LAYOUT ROUTING AND COORDINATE WORK WITH OTHER TRADES BEFORE CONSTRUCTION. 2. MECHANICAL CONTRACTOR SHALL BE

8

RESPONSIBLE FOR CUTTING AND PATCHING OF CONSTRUCTION UNLESS OTHERWISE NOTED ON THE PLANS. NO CUTTING OF STRUCTURAL MEMBERS OR STRUCTURE WHICH WILL DETERIORATE THE INTEGRITY AND STRENGTH OF THE BUILDING WILL BE ALLOWED WITHOUT WRITTEN APPROVAL FROM THE STRUCTURAL ENGINEER.

3. LOCATE ALL VALVES, METERS, GAUGES, AND PIPING SPECIALTIES ABOVE ACCESSIBLE CEILINGS. 4. COORDINATE TEMPERATURE SENSOR LOCATIONS WITH OTHER TRADES, BUILDING ELEMENTS, AND

ELECTRICAL SWITCHES. ADJUST THE EXACT LOCATIONS AS REQUIRED TO AVOID CONFLICTS. 5. BRANCH PIPING TO EQUIPMENT TO BE 3/4" UNLESS OTHERWISE NOTED.

6. ROUTE PIPES BETWEEN JOIST WEBS WHERE REQUIRED TO COORDINATE WITH THE INSTALLATION OF OTHER TRADES AND TO MAINTAIN CEILING HEIGHTS. COORDINATE LOCATIONS PRIOR TO CROSS BRACING TO ENSURE THERE ARE NO CONFLICTS.

7. THE MECHANICAL CONTRACTOR SHALL BE RESPONSIBLE FOR ALL REQUIRED REINFORCEMENT OF NEW AND EXISTING STRUCTURAL MEMBERS FOR MECHANICAL SYSTEMS. REFER TO "MECHANICAL SUPPORT REINFORCEMENT DETAIL" FOR ADDITIONAL REQUIREMENTS.

8. REFER TO M9.10, E5.01, AND E5.02 FOR THE BUILDING ENERGY METERING MATRIX AND RISER DIAGRAM.

9. CONTRACTOR TO PROVIDE BIM CLASH DETECTION IN ACCORDANCE WITH ALL REQUIREMENTS AS INDICATED IN SPECIFICATION

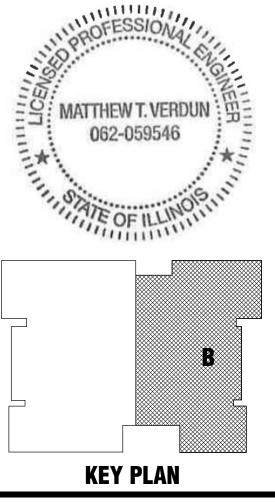
HYDRONIC PLAN KEYED NOTES:

SECTION 01 32 50.

- $\langle \mathbf{1} \rangle$ NATURAL VENTILATION STORM MODE PUSHBUTTON.
- 2 PROVIDE REFRIGERANT PIPING AND SIZE IN ACCORDANCE WITH MANUFACTURER'S GUIDELINES.
- (3) LOCATE HIGH SIDE OF SPACE STATIC PRESSURE SENSOR IN CORRIDOR CEILING IN THIS APPROXIMATE LOCATION.
- $\langle 4 \rangle$ COMBINATION TEMPERATURE AND CO2 SENSOR.
- **5** COMBINATION TEMPERATURE, CO2, AND RH SENSOR.
- $\langle \mathbf{6} \rangle$ COMBINATION TEMPERATURE AND RH SENSOR.
- **T** BACnet BAS IP PANEL. COORDINATE FINAL LOCATION WITH DIV. 23/25/26/27 CONTRACTORS. $\fbox{8} \qquad \text{INSTALL LIQUID DETECTION CABLE AROUND} \\ \text{FLOOR DEPRESSIONS AND CRAC UNIT DRAIN PANS} \\$ UNDER THE RAISED FLOOR. REFER TO 23 09 00 FOR SPECIFICATIONS.
- $\langle 9 \rangle$ HEATING WATER BYPASS VALVE
- $\langle 10
 angle$ CHILLED WATER BYPASS VALVE



RosDrulisCusenbery Architectur



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Matthew T. Verdun License Number: 062-059546 Date 12/30/2022

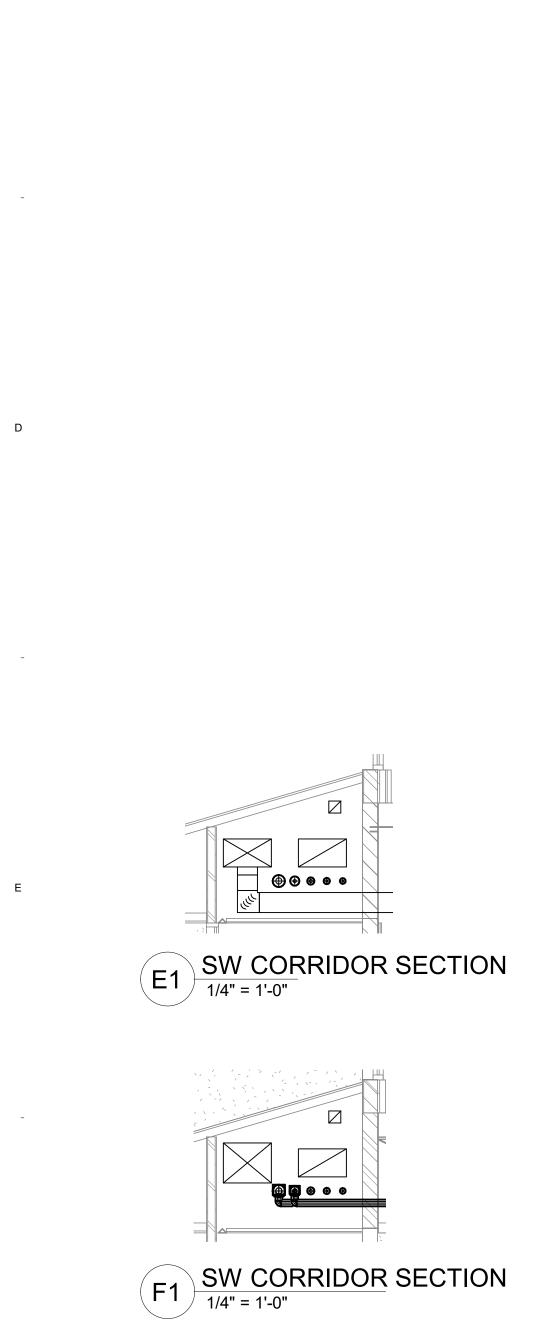
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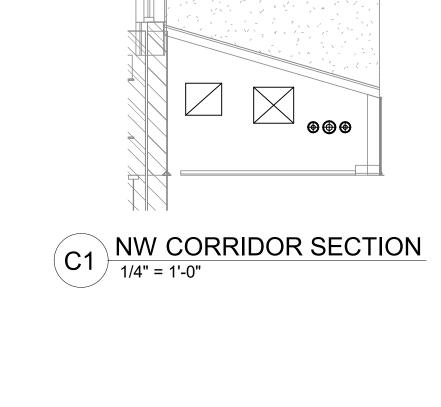
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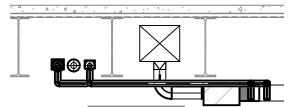


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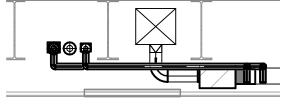
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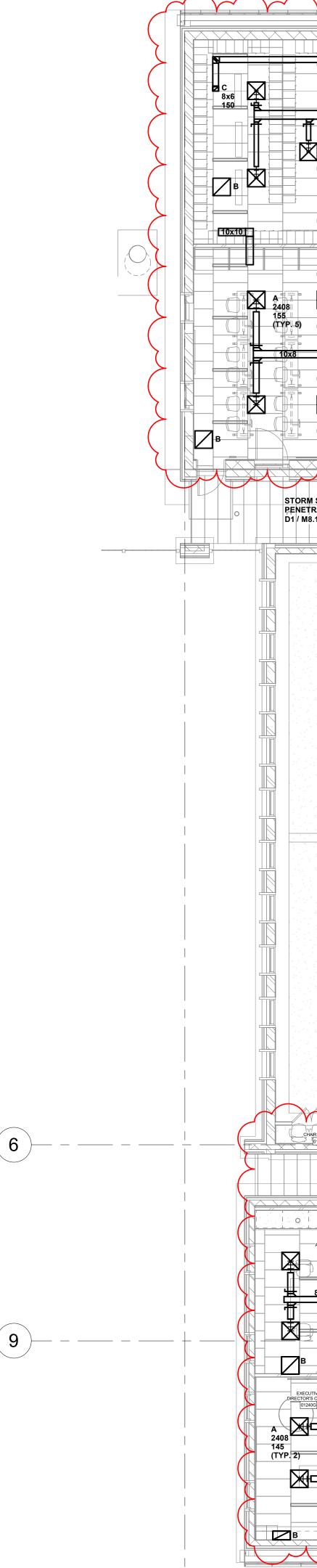
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REFER TO SHEET

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HVAC PLAN KEYED NOTES:

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- ROUTE DUCTS UP BETWEEN JOISTS DIRECTLY ABOVE BOTH HOT AISLES.
- 2 48"x32" LOUVER PLENUM WITH MOTORIZED DAMPER MD-1 FOR STORM MODE NATURAL
- VENTILATION.
- **3** LEAVE CLEAR SPACE WITH NO DUCT ABOVE FOR ELECTRICAL EQUIPMENT/PANEL.
- $\langle 4 \rangle$ BALANCE TO CFM INDICATED.
- 5 104x26 MOTORIZED DAMPER MD-2 ON RETURN INLET OF CRU-1
- 6 104x26 MOTORIZED DAMPER MD-3 ON RETURN INLET OF CRU-2

HVAC PLAN GENERAL NOTES:

1

1. TRANSFER DUCTS AND DUCTS CONNECTED TO TRANSFER FANS SHALL HAVE 1" INTERNAL SOUND ATTENUATING LINER

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ABOVE INACCESSIBLE CEILINGS 3. DIFFUSER DUCT RUNOUTS AND FLEXIBLE DUCT CONNECTIONS SHALL BE THE SAME SIZE AS THE DIFFUSER NECK.

2. DO NOT INSTALL FLEXIBLE DUCT CONNECTIONS

- 4. THE VARIABLE AIR VOLUME CONTROL BOX SHALL BE LOCATED IN A POSITION TO ENSURE ACCESSIBILITY. VARIABLE AIR VOLUME COIL CONNECTIONS SHALL BE ON THE SAME SIDE AS THE CONTROL BOX.
- 5. LOCATE BALANCING DAMPERS ABOVE ACCESSIBLE CEILINGS WHERE POSSIBLE.

6. COORDINATE LOCATIONS OF ANY ACCESS PANELS REQUIRED IN WALLS OR CEILINGS WITH GENERAL CONTRACTOR.

7. ROUTE DUCTS BETWEEN JOISTS AND THROUGH JOIST WEBS WHERE REQUIRED TO COORDINATE WITH THE INSTALLATION OF OTHER TRADES AND TO MAINTAIN CEILING HEIGHTS. COORDINATE LOCATIONS PRIOR TO CROSS BRACING TO ENSURE THERE ARE NO CONFLICTS. AREAS KEYNOTED ARE MINIMUM REQUIRED.

8. DIFFUSER AND REGISTER LOCATIONS SHALL BE COORDINATED WITH LIGHT FIXTURE LOCATIONS AND SHALL BE IN ACCORDANCE WITH CEILING PATTERNS AS SHOWN ON THE ARCHITECTURAL REFLECTED CEILING PLANS.

9. ALL RISES AND DROPS IN DUCTWORK ARE NOT NECESSARILY SHOWN. LAYOUT ROUTING AND COORDINATE WORK WITH OTHER TRADES BEFORE CONSTRUCTION.

10. MECHANICAL CONTRACTOR SHALL BE **RESPONSIBLE FOR CUTTING AND PATCHING OF** CONSTRUCTION UNLESS OTHERWISE NOTED ON THE PLANS. NO CUTTING OF STRUCTURAL MEMBERS OR STRUCTURE WHICH WILL DETERIORATE THE INTEGRITY AND STRENGTH OF THE BUILDING WILL BE ALLOWED WITHOUT WRITTEN APPROVAL FROM THE STRUCTURAL ENGINEER.

11. THE MECHANICAL CONTRACTOR SHALL BE RESPONSIBLE FOR ALL REQUIRED REINFORCEMENT OF NEW AND EXISTING STRUCTURAL MEMBERS FOR MECHANICAL SYSTEMS. REFER TO "MECHANICAL SUPPORT REINFORCEMENT DETAIL" FOR ADDITIONAL REQUIREMENTS.

12. PROVIDE MIN. 3 FT OF CLEARANCE IN FRONT OF VAV ACCESS PANEL.

13. CONTRACTOR TO PROVIDE BIM CLASH DETECTION IN ACCORDANCE WITH ALL REQUIREMENTS AS INDICATED IN SPECIFICATION SECTION 01 32 50

DIVISION 25 BACNET GENERAL NOTES - HVAC

CRU UNITS: CONTROLLER SHALL BE A BACNET/IP SINGLE DEVICE CONTROLLER TYPE OF BACNET INTERFACE DEVICE. THIRD PARTY GATEWAYS THAT ARE NOT FACTORY AUTHORIZED GATEWAYS ARE NOT ALLOWED IN THE WORK. NOTE THAT THE BACNET/IP GATEWAY SHALL BE FACTORY AUTHORIZED PRODUCT PROVIDED BY THE EQUIPMENT SUPPLIER. PROVIDE PROOF OF THIS DURING THE SUBMITTAL PROCESS. SEE DIVISION 25 FOR DETAILS ON THE BACNET OBJECT LIST TO BE PROVIDED AS BACNET AVS, BVS, AND MSVS BY THE EQUIPMENT SUPPLIER. POINT NAMES AND DEVICE NAMES SHALL BE WRITABLE IN THE EQUIPMENT SUPPLIER'S BACNET INTERFACE DEVICE SO THE NAMES CAN BE CHANGED TO THE LAKE COUNTY STANDARD. DEVICES THAT DO NOT SUPPORT WRITABLE DEVICE AND POINT NAMES ARE NOT ALLOWED IN THE WORK. IF THERE ARE POINTS IN THE DEVICE THAT DO NOT APPLY TO THE WORK, THE EQUIPMENT SUPPLIER SHALL WORK ON SITE WITH THE LAKE COUNTY CONTROLS CONSULTANT TO IDENTIFY THESE POINTS THAT DO NOT APPLY TO THE WORK. THEY SHALL BE DELETED FROM THE EQUIPMENT SUPPLIER'S BACNET INTERFACE DEVICE IF THEY ARE NOT USED IN THE WORK. SEE DIVISION 25 FOR BACNET AND NETWORKING DETAILS. ELECTRICAL SHALL PROVIDE AN IP DROP TO THE BACNET/IP DEVICE IN GOLD CONDUIT C/W A PULL WIRE SO DIVISION 27 CAN INSTALL PURPLE CAT 6 CABLE TO THE LAKE COUNTY STANDARD FROM THE DEVICE TO DESIGNATED PATCH PANEL.

THE BASIS OF DESIGN IS LIEBERT VERTIV. CONTROLLER SHALL BE A BACNET/IP SINGLE DEVICE CONTROLLER FOR EACH CRU UNIT. MECHANICAL SHALL PROVIDE NETWORK WIRING BETWEEN THE CRU UNITS TO IMPLEMENT TEAMWORK MODE. EACH CRU UNIT SHALL COME WITH AN ICOM PANEL FOR LOCAL DISPLAY AND MANUAL CONTROL. THE SINGLE DEVICE CONTROLLER SHALL COME C/W AN EMBEDDED LINUX WEBSERVER FOR CONFIGURATION. ALL OTHER DATA SHALL BE TRANSMITTED OVER THE BACNET/IP NETWORK. SEE DIVISION 25 FOR DETAILS.

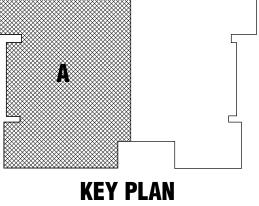
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RosDrulisCusenbery ARCHITECTUR

MATTHEW T. VERDUN 062-059546

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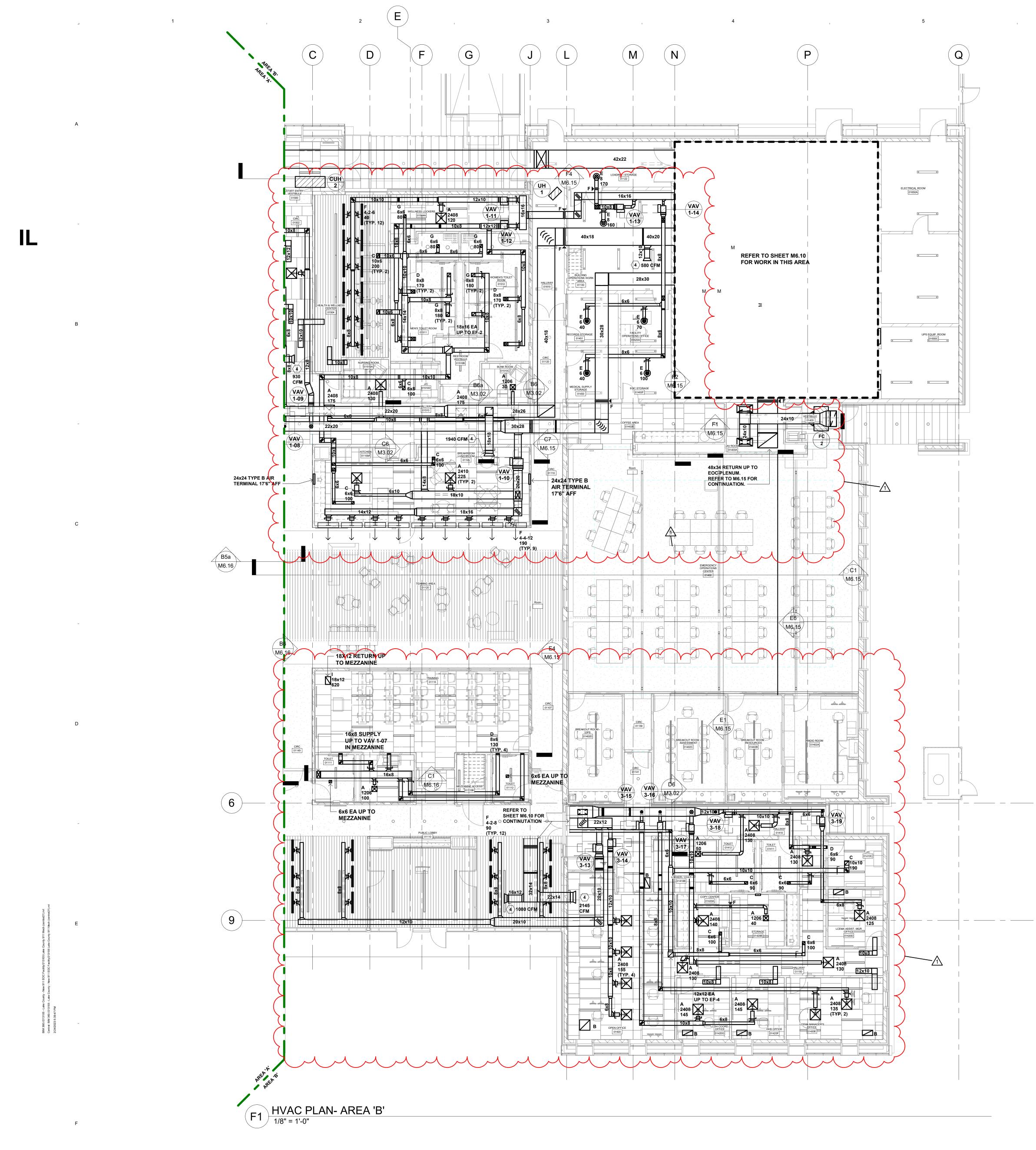


Number: 062-059546 Date 12/30/2022 Revisions Addendum #2 02/24/2

Comm: 213106 Date: 12/30/2022 Drawn: KO \square Check: RP North

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HVAC PLAN-AREA 'A'



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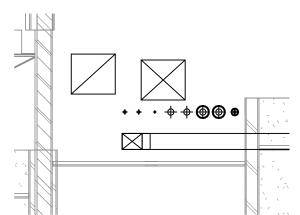
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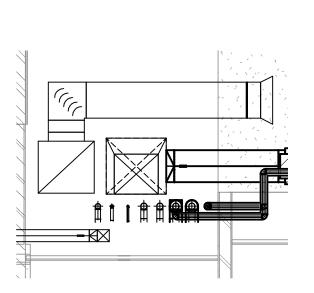
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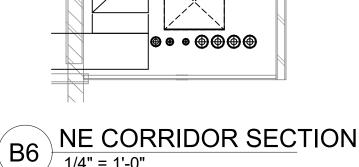
D6 SE CORRIDOR SECTION 1/4" = 1'-0"

C6 NW CORRIDOR SECTION 1/4" = 1'-0"

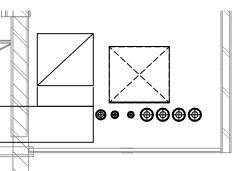


NW CORRIDOR SECTION





1/4" = 1'-0"



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HVAC PLAN GENERAL NOTES:

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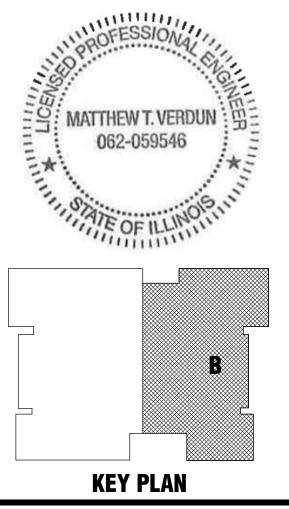
1. TRANSFER DUCTS AND DUCTS CONNECTED TO TRANSFER FANS SHALL HAVE 1" INTERNAL SOUND ATTENUATING LINER

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- 2. DO NOT INSTALL FLEXIBLE DUCT CONNECTIONS ABOVE INACCESSIBLE CEILINGS 3. DIFFUSER DUCT RUNOUTS AND FLEXIBLE DUCT CONNECTIONS SHALL BE THE SAME SIZE AS THE
- DIFFUSER NECK. 4. THE VARIABLE AIR VOLUME CONTROL BOX
- SHALL BE LOCATED IN A POSITION TO ENSURE ACCESSIBILITY. VARIABLE AIR VOLUME COIL CONNECTIONS SHALL BE ON THE SAME SIDE AS THE CONTROL BOX.
- 5. LOCATE BALANCING DAMPERS ABOVE ACCESSIBLE CEILINGS WHERE POSSIBLE. 6. COORDINATE LOCATIONS OF ANY ACCESS PANELS REQUIRED IN WALLS OR CEILINGS WITH
- GENERAL CONTRACTOR. 7. ROUTE DUCTS BETWEEN JOISTS AND THROUGH JOIST WEBS WHERE REQUIRED TO COORDINATE WITH THE INSTALLATION OF OTHER TRADES AND TO MAINTAIN CEILING HEIGHTS. COORDINATE LOCATIONS PRIOR TO CROSS BRACING TO ENSURE
- THERE ARE NO CONFLICTS. AREAS KEYNOTED ARE MINIMUM REQUIRED. 8. DIFFUSER AND REGISTER LOCATIONS SHALL BE COORDINATED WITH LIGHT FIXTURE LOCATIONS AND SHALL BE IN ACCORDANCE WITH CEILING
- PATTERNS AS SHOWN ON THE ARCHITECTURAL REFLECTED CEILING PLANS. 9. ALL RISES AND DROPS IN DUCTWORK ARE NOT NECESSARILY SHOWN. LAYOUT ROUTING AND COORDINATE WORK WITH OTHER TRADES BEFORE
- CONSTRUCTION. 10. MECHANICAL CONTRACTOR SHALL BE **RESPONSIBLE FOR CUTTING AND PATCHING OF** CONSTRUCTION UNLESS OTHERWISE NOTED ON THE PLANS. NO CUTTING OF STRUCTURAL MEMBERS OR STRUCTURE WHICH WILL DETERIORATE THE INTEGRITY AND STRENGTH OF
- THE BUILDING WILL BE ALLOWED WITHOUT WRITTEN APPROVAL FROM THE STRUCTURAL ENGINEER. 11. THE MECHANICAL CONTRACTOR SHALL BE **RESPONSIBLE FOR ALL REQUIRED REINFORCEMENT**
- OF NEW AND EXISTING STRUCTURAL MEMBERS FOR MECHANICAL SYSTEMS. REFER TO "MECHANICAL SUPPORT REINFORCEMENT DETAIL" FOR ADDITIONAL REQUIREMENTS. 12. PROVIDE MIN. 3 FT OF CLEARANCE IN FRONT OF
- VAV ACCESS PANEL. 13. CONTRACTOR TO PROVIDE BIM CLASH DETECTION IN ACCORDANCE WITH ALL REQUIREMENTS AS INDICATED IN SPECIFICATION SECTION 01 32 50
- HVAC PLAN KEYED NOTES:
- **1** ROUTE DUCTS UP BETWEEN JOISTS DIRECTLY ABOVE BOTH HOT AISLES.
- 2 48"x32" LOUVER PLENUM WITH MOTORIZED DAMPER MD-1 FOR STORM MODE NATURAL VENTILATION.
- (3) LEAVE CLEAR SPACE WITH NO DUCT ABOVE FOR ELECTRICAL EQUIPMENT/PANEL.
- $\langle \mathbf{4} \rangle$ BALANCE TO CFM INDICATED.
- $\langle 5 \rangle$ 104x26 MOTORIZED DAMPER MD-2 ON RETURN
- INLET OF CRU-1 6 104x26 MOTORIZED DAMPER MD-3 ON RETURN INLET OF CRU-2



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Matthew T. Verdun License Number: 062-059546 Date 12/30/2022

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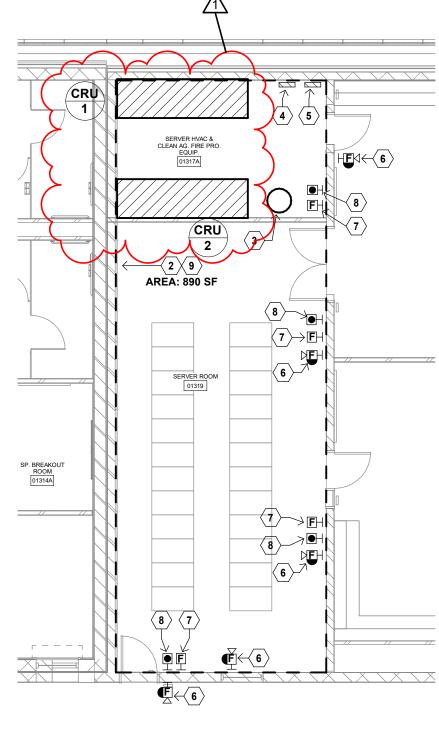
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(F1) SERVER ROOM FIRE PROTECTION PLAN 1/8" = 1'-0"

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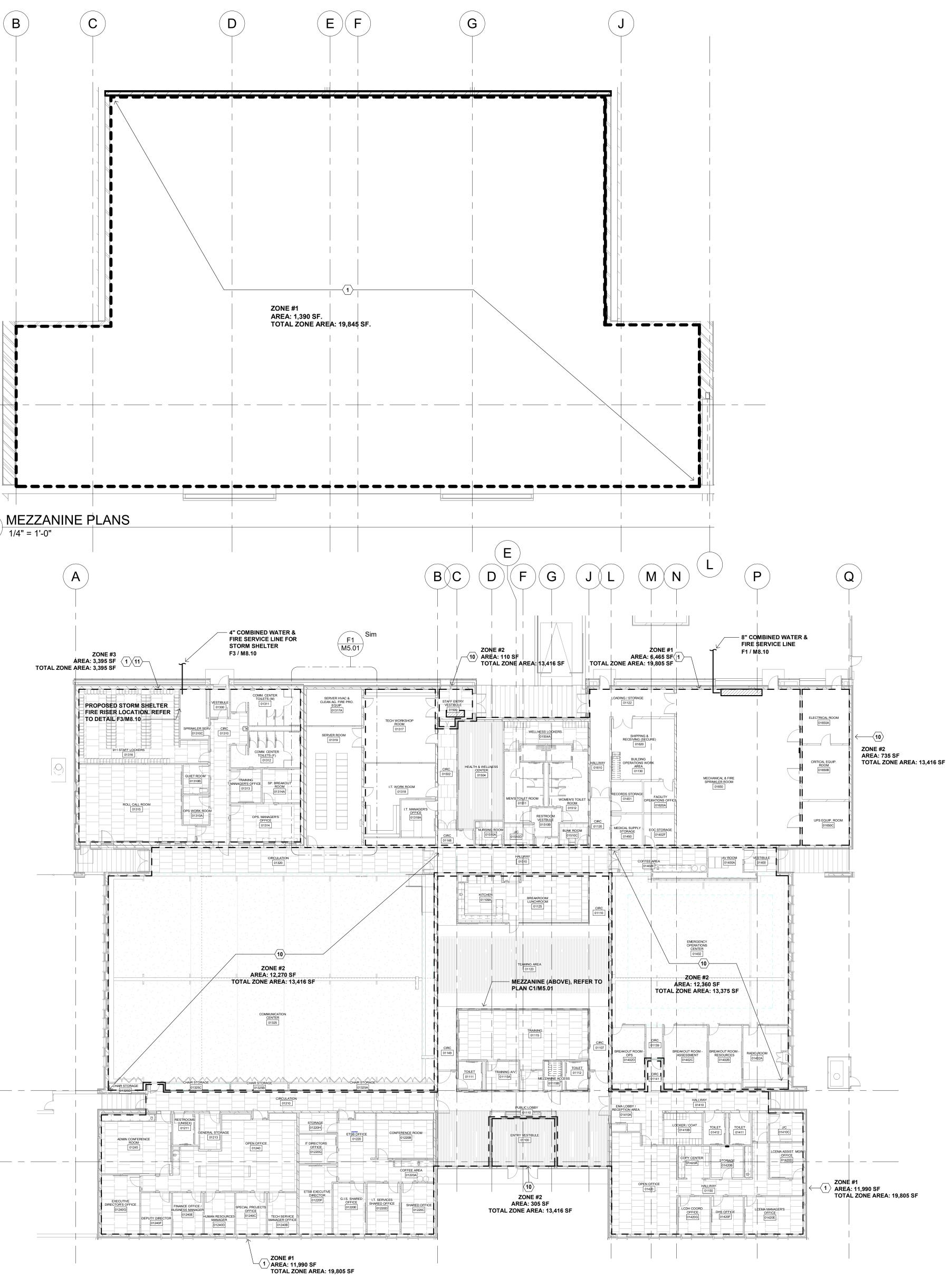
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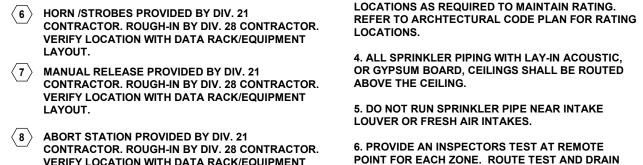
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F3 MAIN LEVEL FIRE PROTECTION PLAN 1/16" = 1'-0"

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FIRE PROTECTION PLAN KEYED NOTES:

 $\langle 1 \rangle$ PROVIDE NEW WET-TYPE FIRE PROTECTION

 $\langle 2 \rangle$ PROVIDE CLEAN AGENT FIRE EXTINGUISHING

 $\langle 4 \rangle$ CLEAN AGENT FIRE SUPPRESSION CONTROL

 $\langle \mathbf{5} \rangle$ VESDA SMOKE DETECTION CONTROL PANEL.

CODE REQUIREMENTS.

 $\langle 3 \rangle$ PROVIDE CLEAN AGENT TANK(S).

SYSTEM.

SYSTEM IN ACCORDANCE WITH ALL NFPA AND

- VERIFY LOCATION WITH DATA RACK/EQUIPMENT
- LAYOUT.
- (9) PROVIDE VESDA SMOKE AIR SAMPLING DETECTION SYSTEM ABOVE AND BELOW RAISED ACCESS
- FLOOR.
- (10) PROVIDE DOUBLE-INTERLOCK PRE-ACTION COVERAGE.
- $\langle 11 \rangle$ STORM SHELTER BOUNDARY.

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9. PROVIDE SPRINKLER HEADS BELOW ALL DUCTWORK THAT CREATES AN OBSTRUCTION TO SPRAY PATTERN AND ALL DUCTWORK GREATER THAN 48" WIDE. 10. FURNISH AND INSTALL PERMANENT PLASTIC LAMINATED SIGNS TO IDENTIFY EACH SPRINKLER

OR QUARTER POINTS OF 2'x4' CEILING TILES AND

WITHIN 2" OF CENTER OF 2'x2' CEILING TILES.

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FIRE PROTECTION PLAN GENERAL NOTES:

CONDUIT

APPROVED MEANS.

1. NO PIPING SHALL BE SUPPORTED FROM JOIST

2. ALL PIPING SHALL BE SUPPORTED FROM TOP

3. FIRE PROTECTION CONTRACTOR IS REQUIRED TO

PROVIDE SLEEVES FOR ALL PIPING PENETRATIONS OF FIRE RESISTIVE OR SMOKE TIGHT WALLS AND

FLOOR OPENINGS. SEAL ALL PIPE PENETRATION

PIPES TO GRADE. PIPES ROUTED TO GRADE SHALL

EXPOSED GALVANIZED PIPE IS NOT ACCEPTABLE.

REFER TO THE END OF SPECIFICATION SECTION 21 10 00 FOR FLOW TEST DATA ATTACHMENT. THIS FIRE PROTECTION CONTRACTOR SHALL CONDUCT THEIR OWN FLOW TEST AT HYDRANT NEAREST BUILDING AND RECORD WATER MAIN SIZE, STATIC AND RESIDUAL PRESSURES, AND G.P.M. FLOW. CONTACT AND COORDINATE FLOW TIME WITH CITY

7. FOR BIDDING PURPOSES A FLOW TEST WAS

PERORMED ON AUGUST 11, 2022 WITH THE

FOLLOWING RESULTS:

WATER DEPARTMENT.

STATIC PRESSURE = 47 PSI

RESIDUAL PRESSURE = 44 PSI TOTAL FLOW = 1418 GPM

TERMINATE WITH A BRASS DRAIN FITTING.

OPENINGS AND FIRE CAULK ALL SLEEVE

BRIDGING OR OTHER PIPING, DUCTWORK, OR

VALVE, THE AREA IT CONTROLS, AND HYDRAULIC DESIGN DATA. 11. FURNISH AND INSTALL PERMANENT PLASTIC

LAMINATE SIGN TO IDENTIFY INSPECTOR TEST CONNECTIONS AND THE ZONE IT SERVES.

12. THE INSTALLATION OF THE FIRE PROTECTION SYSTEM SHALL CONFORM TO I.S.O. AND N.F.P.A. REQUIREMENTS.

13. COORDINATE ALL FIRE PROTECTION PIPING WITH OTHER TRADES. COORDINATION SHALL BE THE RESPONSIBILITY OF THE FIRE PROTECTION

14. ALL AREAS SHALL BE LIGHT HAZARD EXCEPT AS FOLLOWS. REFER TO ARCHITECTURAL FLOOR PLANS FOR ROOM TYPES.

ORDINARY GROUP I JANITORS CLOSET

CONTRACTOR.

MECHANICAL ROOMS ORDINARY GROUP II STORAGE ROOMS

BOILER ROOM SHIPPING/RECEIVING

SECTION 01 32 50.

15. ELECTRICAL ROOMS (ALL VOLTAGES) TO BE SPRINKLED.

17. ALL SPRINKLER HEADS INSTALLED 7'-0" OR LESS SHALL HAVE HEAVY DUTY PROTECTIVE GUARDS. 19. THE MECHANICAL CONTRACTOR SHALL BE

RESPONSIBLE FOR ALL REQUIRED REINFORCEMENT OF NEW AND EXISTING STRUCTURAL MEMBERS FOR MECHANICAL SYSTEMS. REFER TO "MECHANICAL SUPPORT REINFORCEMENT DETAIL" FOR ADDITIONAL REQUIREMENTS.

20. CONTRACTOR TO PROVIDE BIM CLASH DETECTION IN ACCORDANCE WITH ALL REQUIREMENTS AS INDICATED IN SPECIFICATION

DIVISION 25 BACNET GENERAL NOTES - FIRE PROTECTION

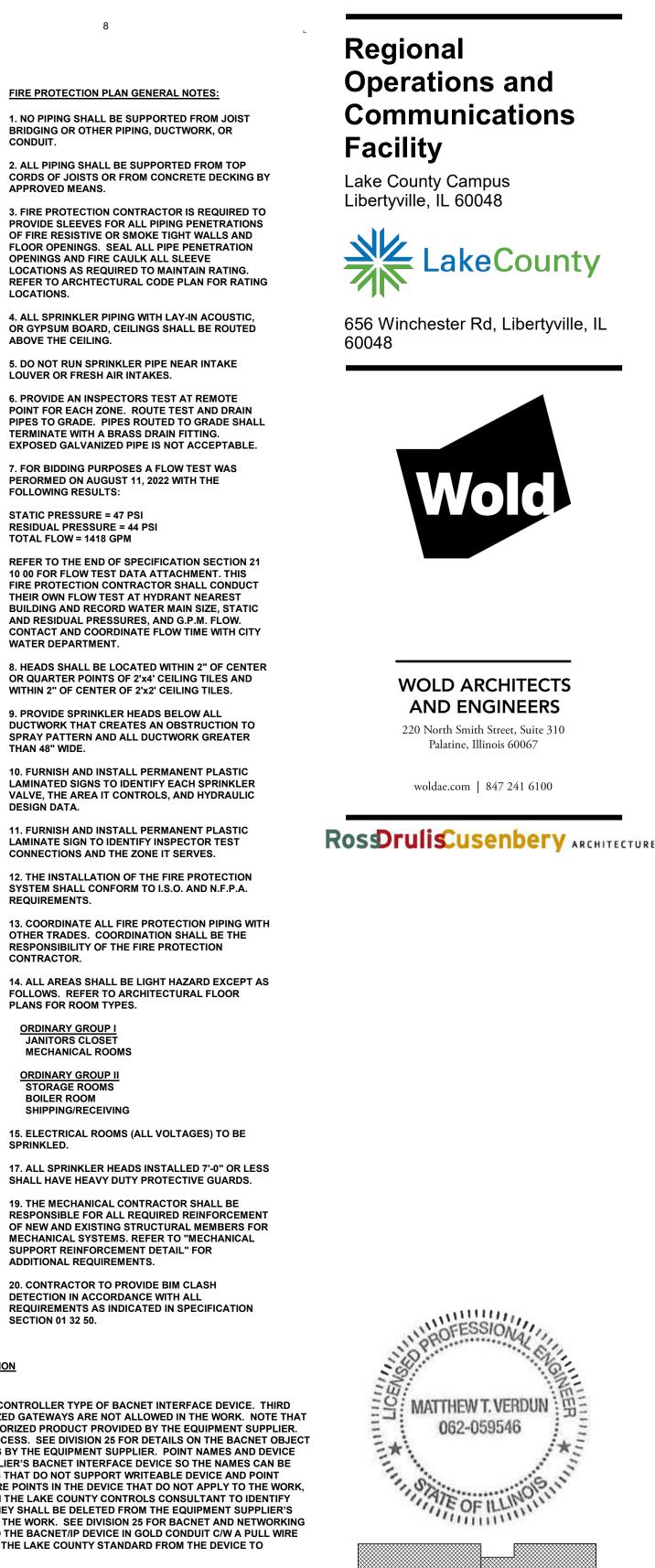
VESDA UNIT: CONTROLLER SHALL BE A BACNET/IP SINGLE DEVICE CONTROLLER TYPE OF BACNET INTERFACE DEVICE. THIRD

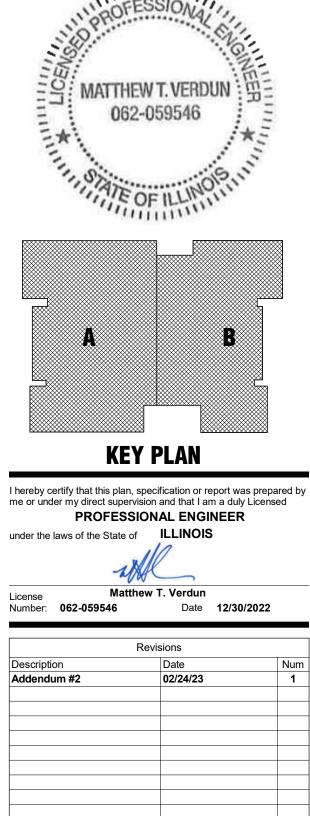
PARTY GATEWAYS THAT ARE NOT FACTORY AUTHORIZED GATEWAYS ARE NOT ALLOWED IN THE WORK. NOTE THAT THE BACNET/IP GATEWAY SHALL BE A FACTORY AUTHORIZED PRODUCT PROVIDED BY THE EQUIPMENT SUPPLIER. PROVIDE PROOF OF THIS DURING THE SUBMITTAL PROCESS. SEE DIVISION 25 FOR DETAILS ON THE BACNET OBJECT LIST TO BE PROVIDED AS BACNET AVS. BVS AND MSVS BY THE EQUIPMENT SUPPLIER. POINT NAMES AND DEVICE NAMES SHALL BE WRITABLE IN THE EQUIPMENT SUPPLIER'S BACNET INTERFACE DEVICE SO THE NAMES CAN BE CHANGED TO THE LAKE COUNTY STANDARD. DEVICES THAT DO NOT SUPPORT WRITEABLE DEVICE AND POINT NAMES ARE NOT ALLOWED IN THE WORK. IF THERE ARE POINTS IN THE DEVICE THAT DO NOT APPLY TO THE WORK, THE EQUIPMENT SUPPLIER SHALL WORK ON SITE WITH THE LAKE COUNTY CONTROLS CONSULTANT TO IDENTIFY THESE POINTS THAT DO NOT APPLY TO THE WORK. THEY SHALL BE DELETED FROM THE EQUIPMENT SUPPLIER'S

BACNET INTERFACE DEVICE IF THEY ARE NOT USED IN THE WORK. SEE DIVISION 25 FOR BACNET AND NETWORKING DETAILS. ELECTRICAL SHALL PROVIDE AN IP DROP TO THE BACNET/IP DEVICE IN GOLD CONDUIT C/W A PULL WIRE SO DIVISION 27 CAN INSTALL PURPLE CAT 6 CABLE TO THE LAKE COUNTY STANDARD FROM THE DEVICE TO DESIGNATED PATCH PANEL. THE BASIS OF DESIGN IS VESDA. THE VESDA BACNET SINGLE DEVICE CONTROLLER SHALL COME WITH THE

EQUIVALENT OF A HLI MODBUS RTU INTERFACE OR APPROVED EQUAL. EQUIPMENT SUPPLIER SHALL PROVIDE A MSA FIELDSERVERFS-8700-43 MODBUS TO BACNET/IP GATEWAY TO MAP THE MODBUS REGISTERS TO BACNET OBJECTS. THE SINGLE DEVICE CONTROLLER SHALL COME C/W AN EMBEDDED LINUX WEBSERVER FOR CONFIGURATION. ALL OTHER DATA SHALL BE TRANSMITTED OVER THE BACNET/IP NETWORK. SEE DIVISION 25 FOR DETAILS.

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Comm: 213106 Date: 12/30/2022 Drawn: **KO** Check: RP North

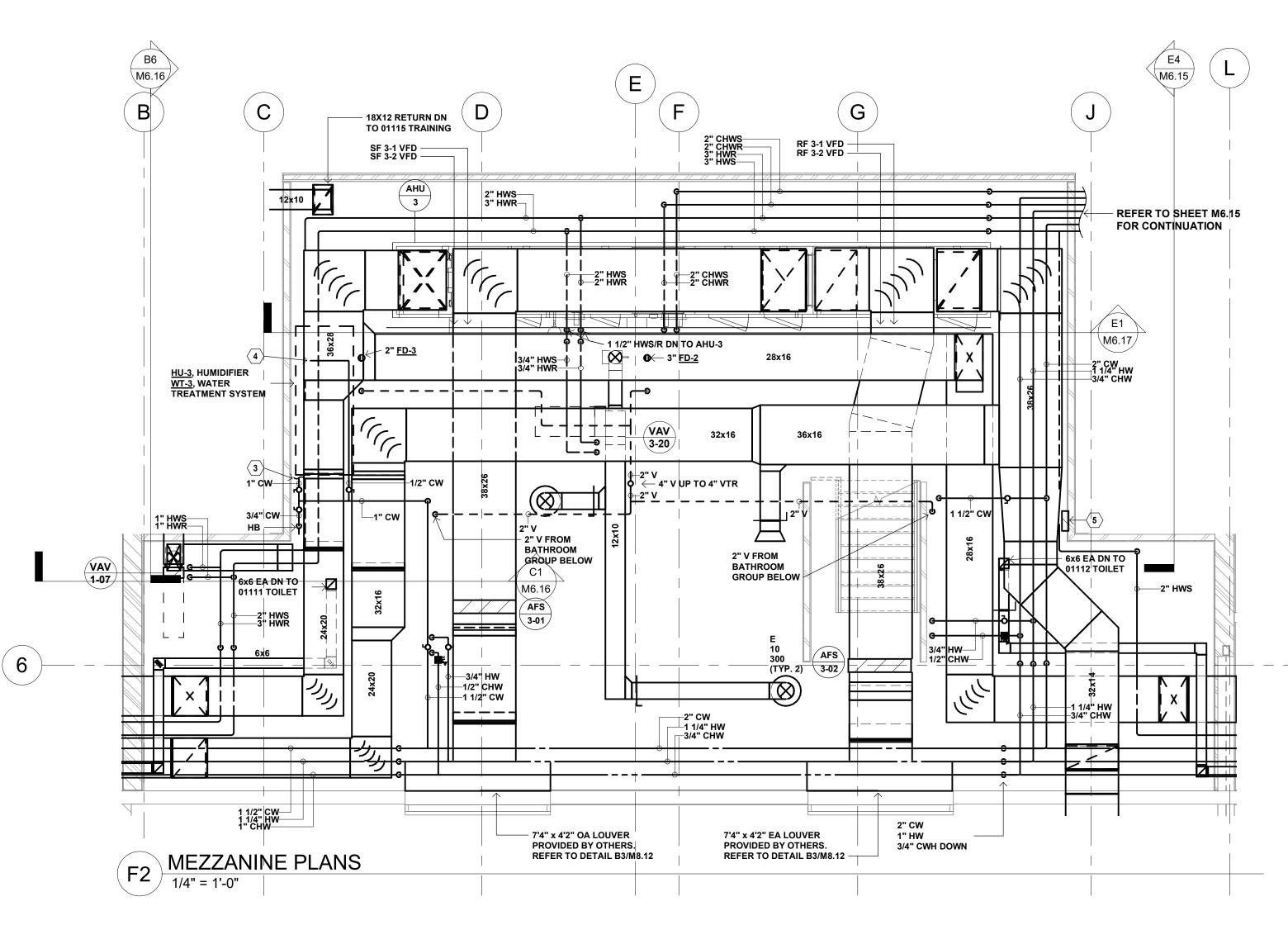
FIRE PROTECTION PLAN

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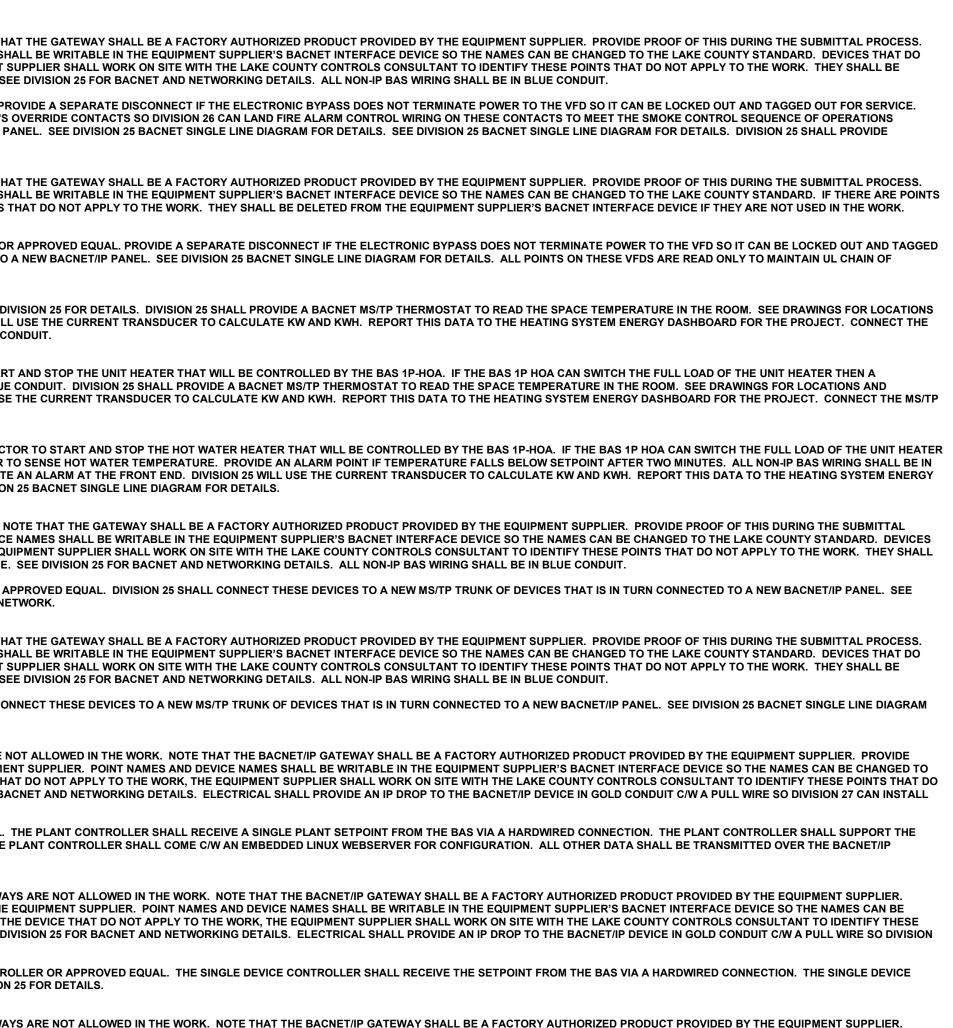
2 1 3 1 DIVISION 25 BACNET GENERAL NOTES - BOILER AND MECH ROOM GENERAL NOTES VFDS ALL VFDS SHALL COME WITH A BACNET MS/TP INTERFACE. THIRD PARTY GATEWAYS THAT ARE NOT FACTORY AUTHORIZED PRODUCT PROVIDED BY THE EQUIPMENT SUPPLIER. PROVIDE PROOF OF THIS DURING THE SUBMITTAL PROCESS. SEE DIVISION 25 FOR DETAILS ON THE BACNET OBJECT LIST TO BE PROVIDED AS BACNET AVS, BVS AND MSVS BY THE EQUIPMENT SUPPLIER'S BACNET INTERFACE DEVICE SO THE NAMES CAN BE CHANGED TO THE LAKE COUNTY STANDARD. DEVICES THAT DO NOT SUPPORT WRITEABLE DEVICE AND POINT NAMES ARE NOT ALLOWED IN THE WORK. IF THERE ARE POINTS IN THE DEVICE THAT DO NOT APPLY TO THE WORK. THE EQUIPMENT SUPPLIER SHALL WORK ON SITE WITH THE LAKE COUNTY CONTROLS CONSULTANT TO IDENTIFY THESE POINTS THAT DO NOT APPLY TO THE WORK. THEY SHALL BE DELETED FROM THE EQUIPMENT SUPPLIER'S BACNET INTERFACE DEVICE IF THEY ARE NOT USED IN THE WORK. DIVISION 25 IS RESPONSIBLE FOR NETWORKING TO THIS DEVICE. SEE DIVISION 25 FOR BACNET AND NETWORKING DETAILS. ALL NON-IP BAS WIRING SHALL BE IN BLUE CONDUIT. THE BASIS OF DESIGN FOR THIS DEVICE IS ABB ACH550. ALL VFDS SHALL COME WITH THE EQUIVALENT OF AN ABB ACH550 ECLIPSE ELECTRONIC BYPASS OR APPROVED EQUAL. PROVIDE A SEPARATE DISCONNECT IF THE ELECTRONIC BYPASS DOES NOT TERMINATE POWER TO THE VFD SO IT CAN BE LOCKED OUT AND TAGGED OUT FOR SERVICE. EACH PUMP AND EACH AHU FAN MOTOR SHALL COME WITH A VFD. APPROVED VFD SUPPLIERS ARE ABB, DANFOSS AND YASKAWA. THE VFD SHALL HAVE UL-APPROVED FIREMAN'S OVERRIDE CONTACTS SO DIVISION 26 CAN LAND FIRE ALARM CONTROL WIRING ON THESE CONTACTS TO MEET THE SMOKE CONTROL SEQUENCE OF OPERATIONS SPECIFIED IN THE CONTRACT DOCUMENTS. DIVISION 25 SHALL CONNECT THESE DEVICES TO A NEW MS/TP TRUNK OF DEVICES THAT IS IN TURN CONNECTED TO A NEW BACNET //P PANEL. SEE DIVISION 25 BACNET SINGLE LINE DIAGRAM FOR DETAILS. DIVISION 25 SHALL PROVIDE HARDWIRED CONNECTIONS FOR VFD ENABLE, VFD SPEED AND VFD COMMON ALARM. ALL OTHER POINTS ARE TRANSMITTED OVER THE BACNET MS/TP NETWORK. FIRE PUMP VFDS: ALL VFDS SHALL COME WITH A BACNET MS/TP INTERFACE. THIRD PARTY GATEWAYS THAT ARE NOT FACTORY AUTHORIZED PRODUCT PROVIDED BY THE EQUIPMENT SUPPLIER. PROVIDE PROOF OF THIS DURING THE SUBMITTAL PROCESS. SEE DIVISION 25 FOR DETAILS ON THE BACNET OBJECT LIST TO BE PROVIDED AS BACNET AVS, BVS AND MSVS BY THE EQUIPMENT SUPPLIER'S BACNET INTERFACE DEVICE SO THE NAMES CAN BE CHANGED TO THE LAKE COUNTY STANDARD. IF THERE ARE POINTS IN THE DEVICE THAT DO NOT APPLY TO THE WORK, THE EQUIPMENT SUPPLIER SHALL WORK ON SITE WITH THE LAKE COUNTY CONTROLS CONSULTANT TO IDENTIFY THESE POINTS THAT DO NOT APPLY TO THE WORK. THEY SHALL BE DELETED FROM THE EQUIPMENT SUPPLIER'S BACNET INTERFACE DEVICE IF THEY ARE NOT USED IN THE WORK. DIVISION 25 IS RESPONSIBLE FOR NETWORKING TO THIS DEVICE. SEE DIVISION 25 FOR BACNET AND NETWORKING DETAILS. ALL NON-IP BAS WIRING SHALL BE IN BLUE CONDUIT. 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WHEN THERE IS A CALL FOR HEAT AND THE AMP READING IS ZERO FOR 2 MINUTES (USER SETTABLE), GENERATE AN ALARM AT THE FRONT END. DIVISION 25 WILL USE THE CURRENT TRANSDUCER TO CALCULATE KW AND KWH. REPORT THIS DATA TO THE HEATING SYSTEM ENERGY DASHBOARD FOR THE PROJECT. CONNECT THE MS/TP TRUNK OF DEVICES TO A NEW NON UL-LISTED BACNET/IP PANEL. SEE DIVISION 25 BACNET SINGLE LINE DIAGRAM FOR DETAILS. ALL NON-IP BAS WIRING SHALL BE IN BLUE CONDUIT. UNIT HEATERS: DIVISION 25 SHALL PROVIDE A STARTER FOR EACH UNIT HEATER EQUAL TO FRANKLIN BAS-1P TO ALLOW FOR HOA CONTROL. ELECTRICAL SHALL PROVIDE A CONTACTOR TO START AND STOP THE UNIT HEATER THAT WILL BE CONTROLLED BY THE BAS 1P-HOA. IF THE BAS 1P HOA CAN SWITCH THE FULL LOAD OF THE UNIT HEATER THAN AND STOP THE UNIT HEATER THAT WILL BE CONTROLLED BY THE BAS 1P-HOA. IF THE BAS 1P HOA CAN SWITCH THE FULL LOAD OF THE UNIT HEATER THAN AND STOP THE UNIT HEATER THAT WILL BE CONTROLLED BY THE BAS 1P-HOA. 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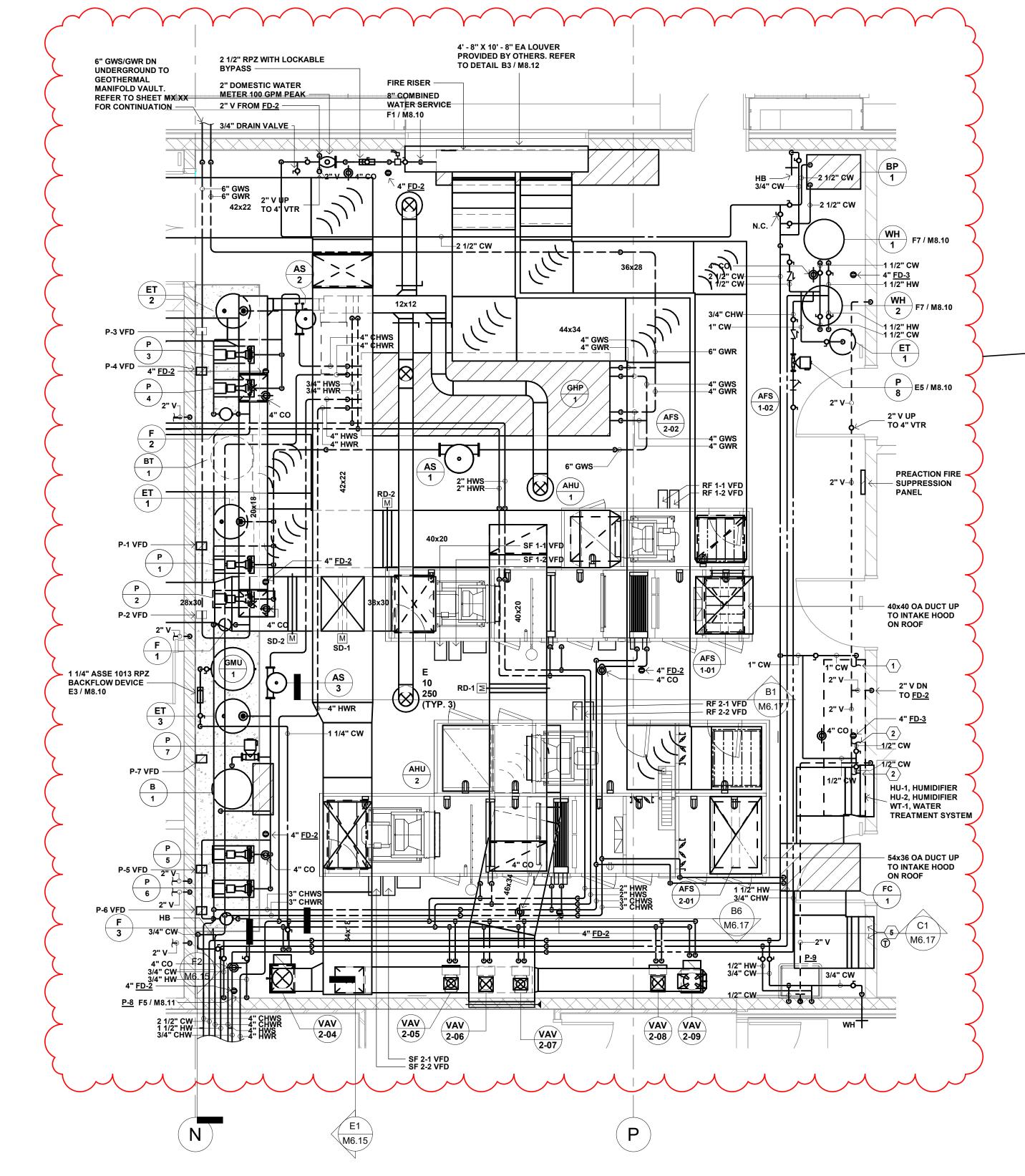
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BOILER/MECHANICAL ROOM PLAN

6. CONTRACTOR TO PROVIDE BIM CLASH DETECTION IN ACCORDANCE WITH ALL

REQUIREMENTS AS INDICATED IN SPECIFICATION

- RESPONSIBLE FOR ALL REQUIRED REINFORCEMENT OF NEW AND EXISTING STRUCTURAL MEMBERS FOR MECHANICAL SYSTEMS. REFER TO "MECHANICAL SUPPORT REINFORCEMENT DETAIL" FOR ADDITIONAL REQUIREMENTS.
- SIZES AND LOCATIONS. 5. THE MECHANICAL CONTRACTOR SHALL BE
- 4. REFER TO ARCHITECTURAL PLANS FOR
- CONCRETE CURBS AND PADS. COORDINATE EXACT
- 3. VERIFY EXACT LOCATIONS OF FLOOR DRAINS WITH ARCHITECTURAL PLANS.
- APPROVAL FROM THE STRUCTURAL ENGINEER.

- 5 BACnet IP BAS PANEL. COORDINATE FINAL LOCATION WITH DIV. 23/25/26/27 CONTRACTORS
- DRAIN TO FLOOR DRAIN.
- CONNECT 1/2" CW TO HU-3 HUMIDIFIER DRAIN WATER TEMPERING SYSTEM. ROUTE HUMIDIFIER
- THEN CONNECT R.O. WATER TO HU-3 HUMIDIFIER. ROUTE ALL EQUIPMENT DRAINS TO FLOOR DRAIN.
- THEN CONNECT SOFT CW TO WT-3 R.O. SYSTEM.
- CONNECT 1" CW TO WT-3 SOFTENER SYSTEM,
- DRAIN WATER TEMPERING SYSTEM. ROUTE HUMIDIFIER DRAINS TO FLOOR DRAIN.
- FLOOR DRAIN. 2 CONNECT 1/2" CW TO HU-1 AND HU-2 HUMIDIFIER
- HUMIDIFIERS. ROUTE ALL EQUIPMENT DRAINS TO
- CONNECT 1" CW TO WT-1 SOFTENER SYSTEM. THEN CONNECT SOFT CW TO WT-1 R.O. SYSTEM, THEN CONNECT R.O. WATER TO HU-1 AND HU-2
- BOILER ROOM PLAN KEYED NOTES:

2. MECHANICAL CONTRACTOR SHALL BE **RESPONSIBLE FOR CUTTING AND PATCHING OF** CONSTRUCITON UNLESS OTHERWISE NOTED ON THE PLANS. NO CUTTING OF STRUCTURAL

1. ALL RISES AND DROPS IN DUCTWORK ARE NOT

COORDINATE WORK WITH OTHER TRADES BEFORE

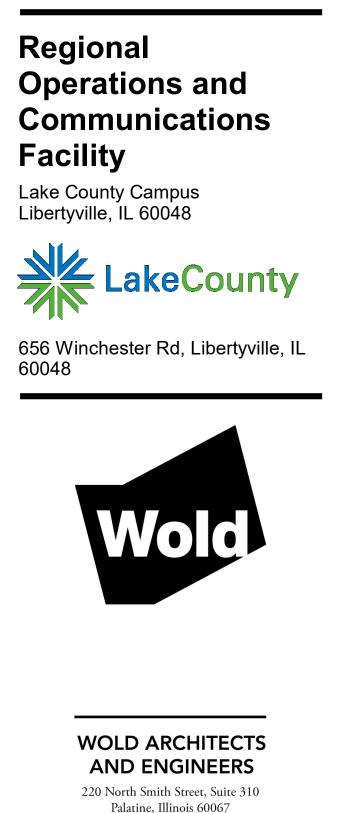
NECESSARILY SHOWN. LAYOUT ROUTING AND

BOILER ROOM PLAN GENERAL NOTES:

CONSTRUCTION

SECTION 01 32 50.

MEMBERS OR STRUCTURE WHICH WILL DETERIORATE THE INTEGRITY AND STRENGTH OF THE BUILDING WILL BE ALLOWED WITHOUT WRITTEN

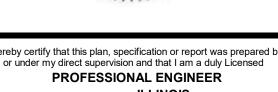


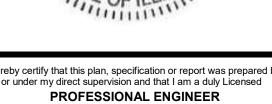
woldae.com | 847 241 6100

Ros Drulis usenbery Architectur



hereby certify that this plan, specification or report was prepared by me or under my direct supervision and that I am a duly Licensed PROFESSIONAL ENGINEER under the laws of the State of **ILLINOIS**





Matthew T. Verdur

Revisions 02/24/2 Addendum #2

Number: 062-059546 Date 12/30/2022

Comm: **213106**

Check: RP

Date: 12/30/2022

BOILER AND

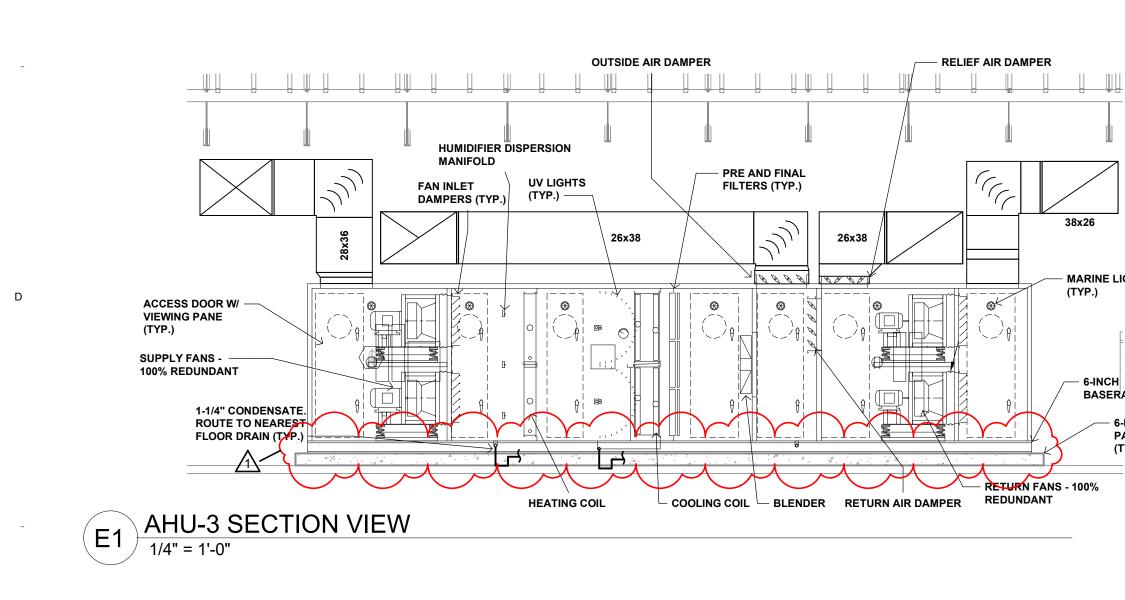
MECHANICAL

ROOM PLAN

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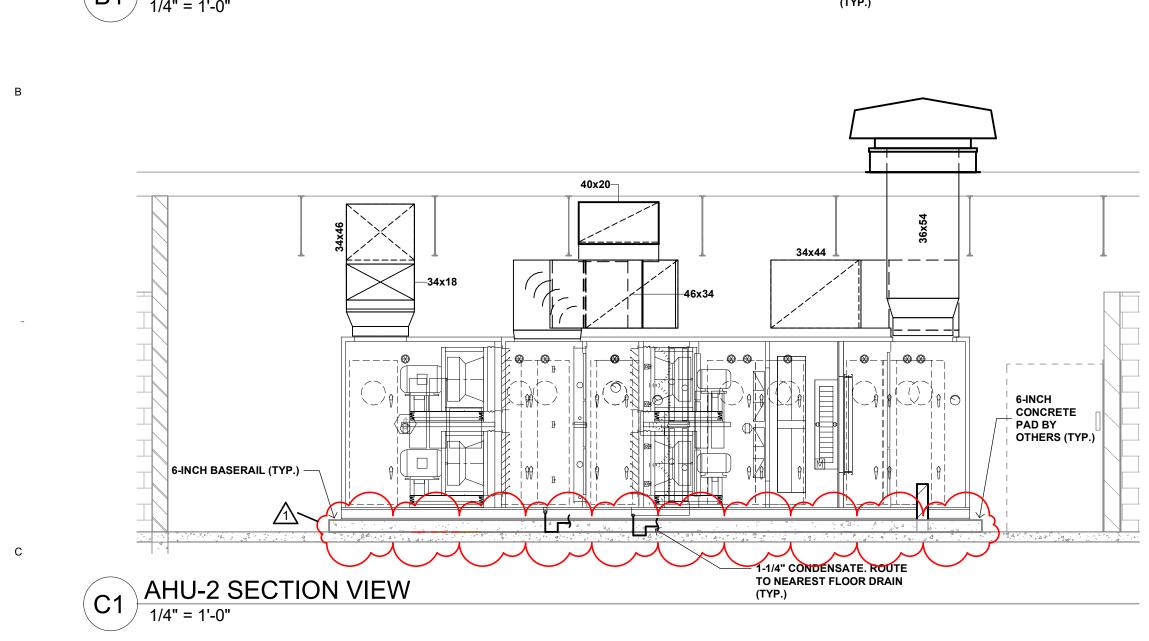


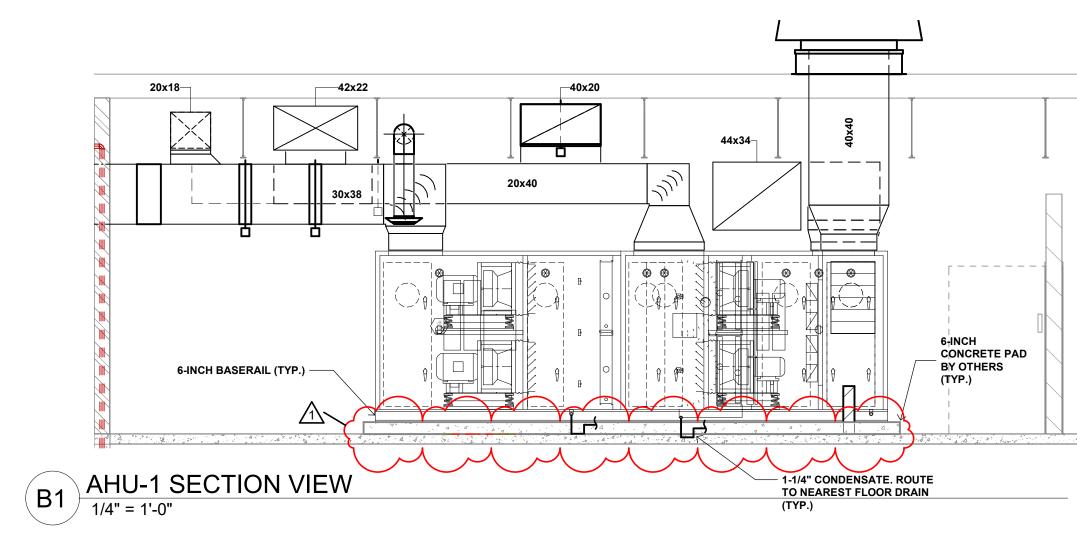
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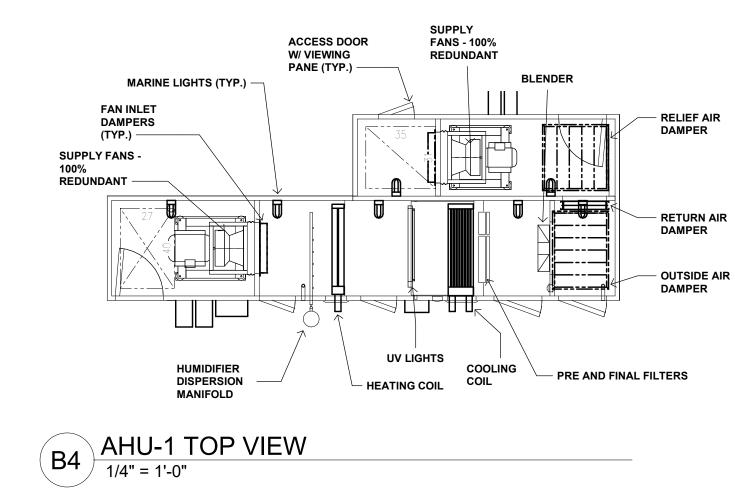
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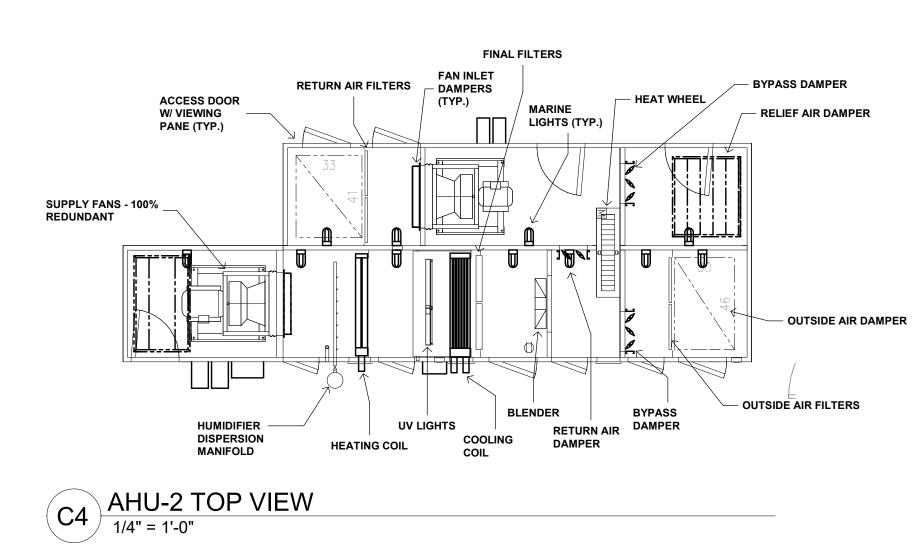
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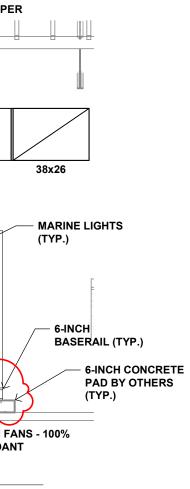


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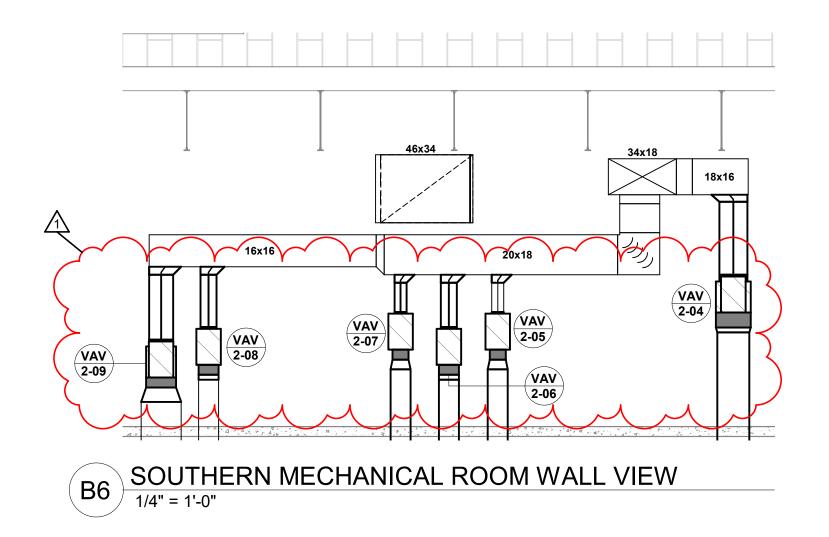
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Scale: 1/4" = 1'-0"



Comm: 213106

Date: 12/30/2022 Drawn: KO Check: **RP** MECHANICAL

Date Addendum #2 02/24/23

Matthew T. Verdun License Number: 062-059546 Date 12/30/2022

Revisions

under the laws of the State of ILLINOIS

I hereby certify that this plan, specification or report was prepared by me or under my direct supervision and that I am a duly Licensed PROFESSIONAL ENGINEER





RosDruliSusenbery ARCHITECTUR



Operations and Communications Facility Lake County Campus Libertyville, IL 60048

656 Winchester Rd, Libertyville, IL 60048

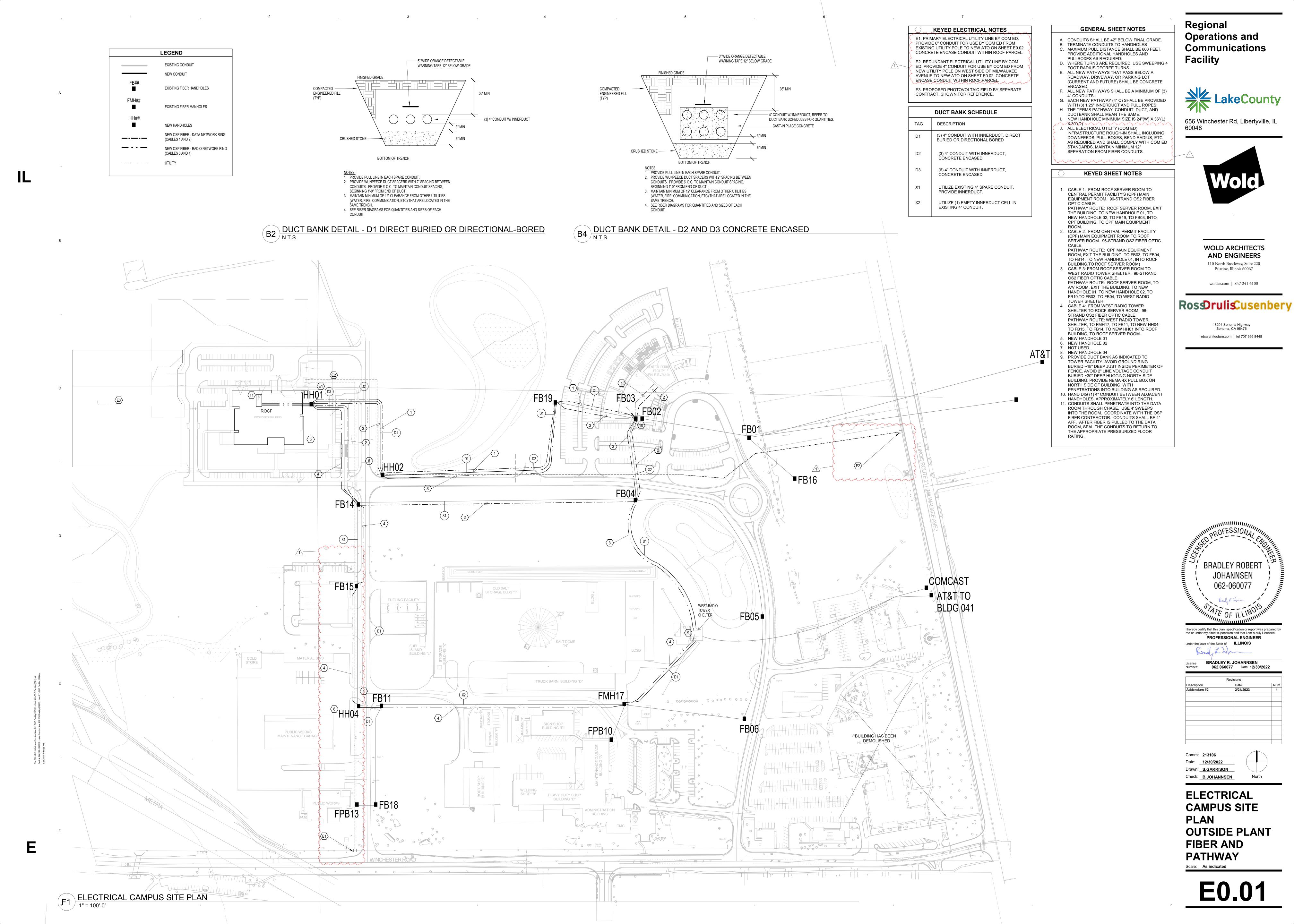
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BIM 360//213105 - Lake County - New 911 EOC Facility/213105 - New 911-EOC Facility- (C21),n1 Central: BIM 360/213105 - Lake County - New 911 EOC Facility/213105 - New 911-EOC Facility (C21),n1 2/24/2023 10:59:41 AM	E1 ELECTRICAL SITE PLAN 1" = 30'-0"	

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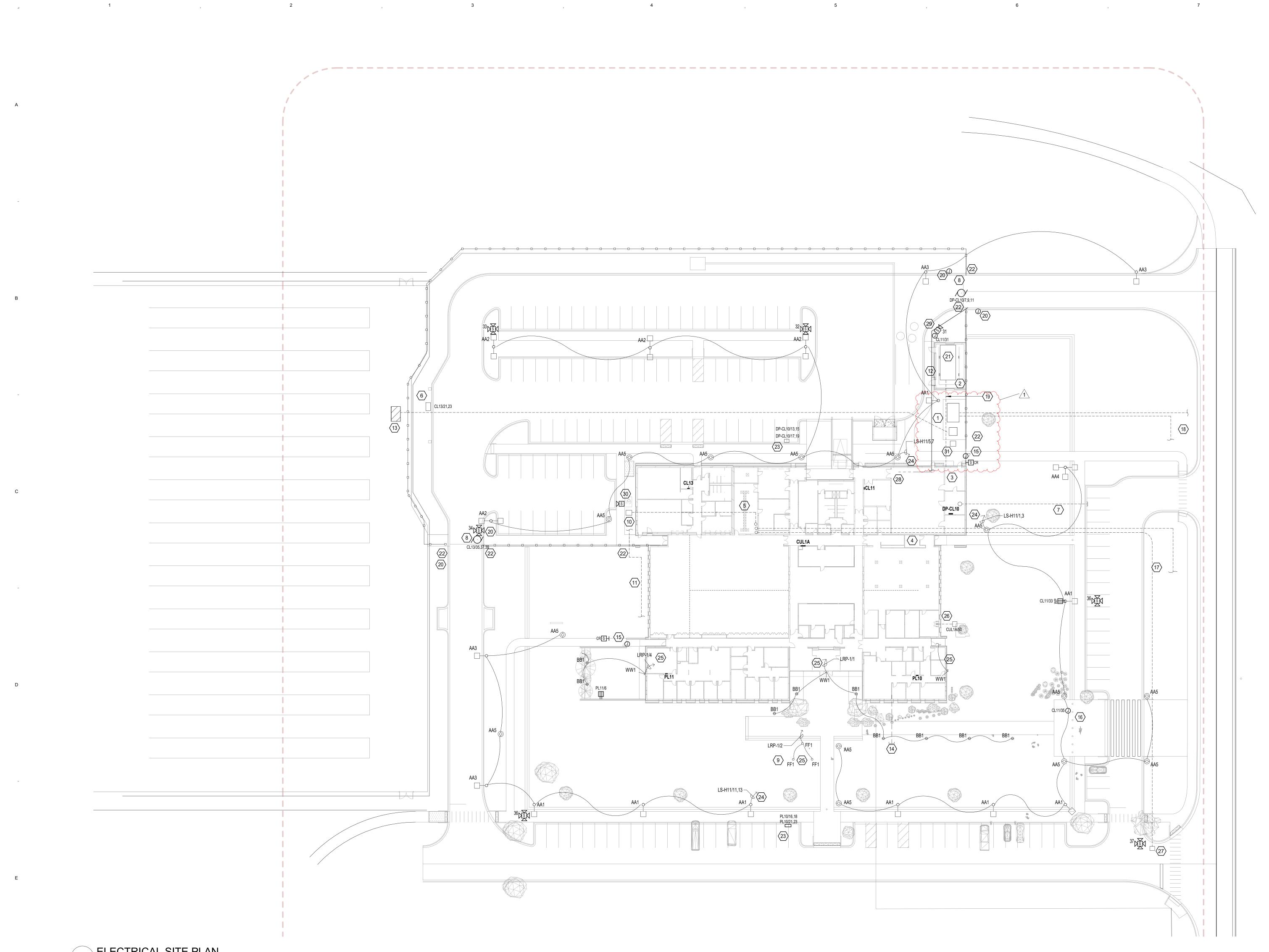
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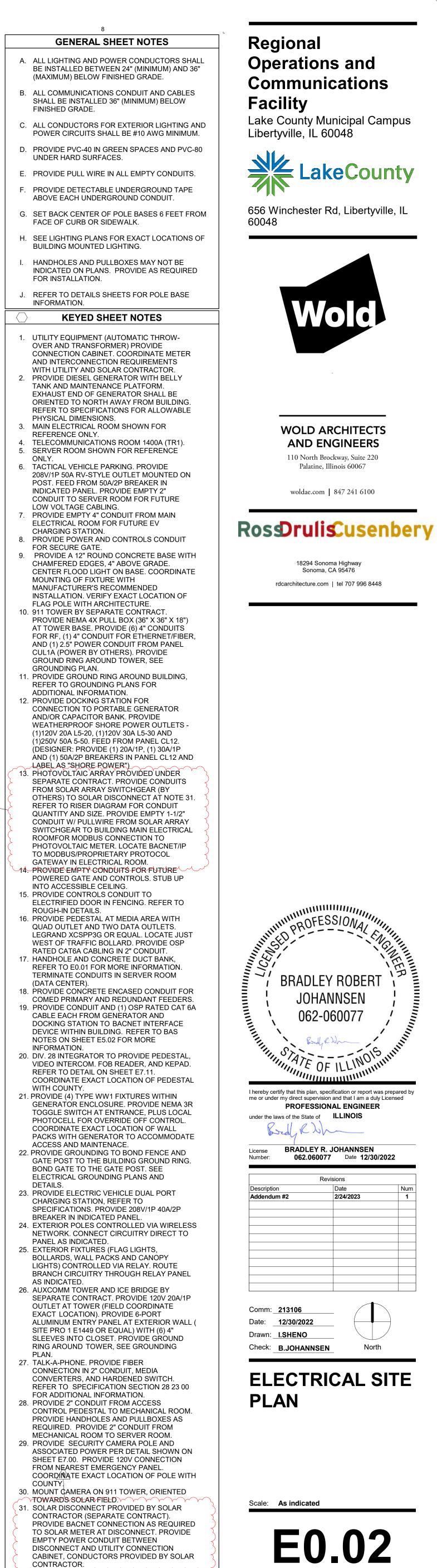
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MARK	INTENDED LOCATIONS OF USE	WALL SWITCH #LEGS	OCC SENSOR LOCATION	MANUAL /AUTO	DIMMING	DAY Light
$\langle A \rangle$	OPEN OFFICES, CONFERENCE ROOMS, LARGE OFFICES	SEE PLANS	CEILING	MANUAL	Х	
B	SMALL OFFICES	1	WALL	MANUAL	Х	
$\langle \hat{\mathbf{C}} \rangle$	MULTI-STALL TOILETS, LOCKERS, WELLENESS		CEILING	AUTO		
D	PRIVATE TOILETS	1	WALL	AUTO		
E	LARGE STORAGE, BREAKROOM	SEE PLANS	CEILING	MANUAL		
F	SM STORAGE, J/C	1	WALL	MANUAL		
Ġ	CORRIDORS, COPY ROOMS	NONE	CEILING	AUTO		
Ĥ	MECH/ELEC ROOMS	LINE	NONE	NA		
$\langle \rangle$	SERVER ROOM	SEE PLANS	CEILING	MANUAL		
$\langle \dot{\mathbf{y}} \rangle$	BREAKOUT/RADIO	SEE PLANS	WALL/CORNER	MANUAL	Х	Х
ĸ	ENTRY VESTIBULE	NONE	LIGHT	SEE PLANS	Х	Х
(L)	COMM CENTER, EMERGENCY OPERATIONS, TEAMING	SEE PLANS	SEE PLANS	SEE PLANS	Х	Х
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SEE NOTES

SEE NOTES

SEE NOTES

A. SCHEMES ARE SCHEMATIC. PROVIDE WIRING AND COMPONENTS AS REQUIRED.

B. PROVIDE MULTIPLE SWITCH LOCATIONS (3-WAY SWITCHING) IF INDICATED ON PLANS.C. INTERCONNECT ALL SENSORS IF MULTIPLE SENSORS ARE SHOWN WITHIN SAME ROOM, UNLESS INDICATED OTHERWISE.

D. PROVIDE EMERGENCY RELAYS AS INDICATED ON PLANS.
 E. PROVIDE OCCUPANCY CONTROL FOR 50% OF POWER OUTLETS, EXCEPT WITHIN DCOA (DESIGNATED CRITICAL OPERATION AREA). CONTROLLED-OUTLET AREAS INCLUDE OFFICES, CONFERENCE ROOMS, COPY ROOMS, ETC. REFER TO POWER PLANS FOR CORRESPONDING INFORMATION.

PROVIDE NETWORK CONTROL AT ALL ROOMS TO ALLOW FOR DEMAND RESPONSE CONTROL OF BUILDING LIGHTING.

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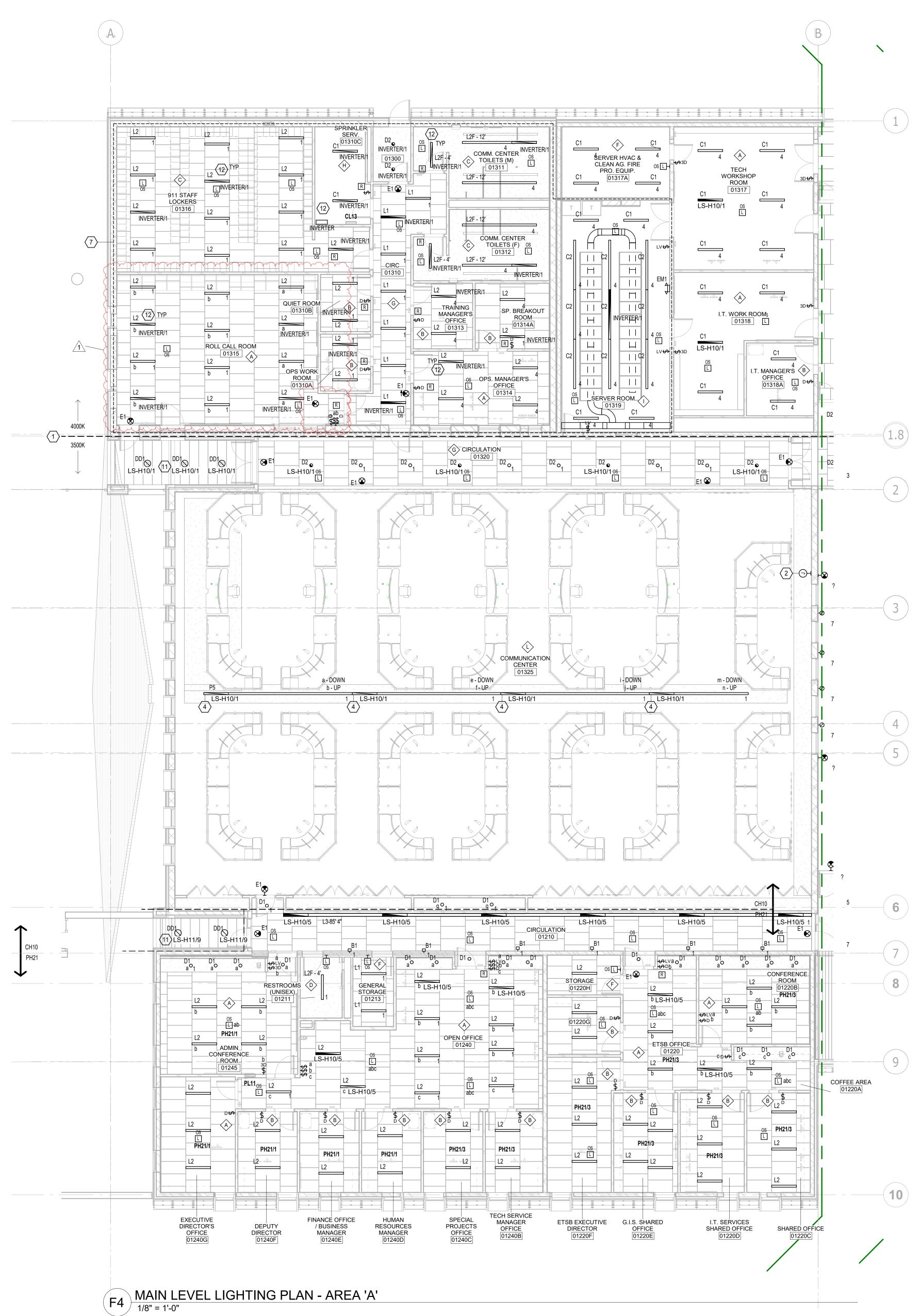
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	ACCORDING TO THE CIRCUIT BREAKER RATING, UNLESS INDICATED OTHERWISE ON THE ELECTRICAL EQUIPMENT SCHEDULE.
С.	ALL BOXES, CONDUIT AND WIRING TO BE CONCEALED. NO EXPOSED BOXES, CONDUIT AND WIRING SHALL BE ALLOWED UNLESS NOTED OTHERWISE.
D.	NO MULTI-BRANCH CIRCUIT ALLOWED. PROVIDE A SEPARATE NEUTRAL WITH EACH CIRCUIT.
Ξ.	COORDINATE LUMINAIRE LOCATIONS WITH OTHER TRADES INCLUDING HVAC EQUIPMENT, DUCTWORK, SPRINKLER PIPING AND BUILDING STRUCTURAL MEMBERS.
=.	PROVIDE SEPARATED CONDUITS FOR ALL EMERGENCY AND EGRESS LIGHTING CIRCUITS, DO NOT COMBINE WITH NORMAL BUILDING WIRING.
G.	ALL EXIT SIGNS AND BATTERY EGRESS FIXTURES TO BE CONNECTED TO NEAREST EMERGENCY LIGHTING CIRCUIT AHEAD OF ANY SWITCHING.
┥.	ALL EXTERIOR LIGHTING TO BE CONNECTED TO LIGHTING CONTROL RELAY SYSTEM UNLESS NOTED OTHERWISE.
	LIGHT FIXTURE WHIPS OF TYPE AC AND TYPE MC WITH GROUND WIRE SHALL BE ALLOWED ONLY ABOVE ACCESSIBLE GRID-TYPE SUSPENDED CEILING. MAX LENGTH OF 6 FEET. MAXIMUM OF 4 WHIPS PER JUNCTION BOX. DIRECT FIXTURE TO FIXTURE CONNECTIONS ARE NOT ALLOWED.
J.	REFER TO LAKE COUNTY CONDUIT COLOR REQUIREMENTS, SEE SYMBOL SHEET AND CONDUIT SPECIFICATIONS.
	NORMAL OPERATING LIGHT FIXTURE. FEED FIXTURE USING EXISTING LIGHTING CIRCUITRY FROM NORMAL PANEL.
	SWITCHED EMERGENCY LIGHT. FEED FIXTURE FROM PANEL LS- H10 VIA EMERGENCY RELAY AS INDICATED ON PLAN.
	UNSWITCHED EMERGENCY LIGHT (NIGHT LIGHT). FEED FIXTURE FROM UNSWITCHED CIRCUIT IN PANEL LS-H10.
	EXIT LIGHT. FEED FROM UNSWITCHED CIRCUIT IN PANEL LS-H10.
	FIXTURE TYPE
	A NL - FIXTURE NOTES
	RELAY #/ PANEL CIRCUIT #
	ab rl-1 SWITCHING SCHEME
	 MAXIMUM ALLOWABLE WATTAGE FOR A LIGHTING CIRCUIT WILL NOT EXCEED 3500 (277V) OR 1600 (120V) WATTS.

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GENERAL SHEET NOTES

. CIRCUIT NUMBERS AT DEVICES CORRESPOND TO PANELBOARD BREAKERS (SEE PANELBOARD

SCHEDULE). BRANCH CIRCUITS SHALL BE SIZED

A. SOME NOTES MAY NOT APPLY TO THIS SHEET.

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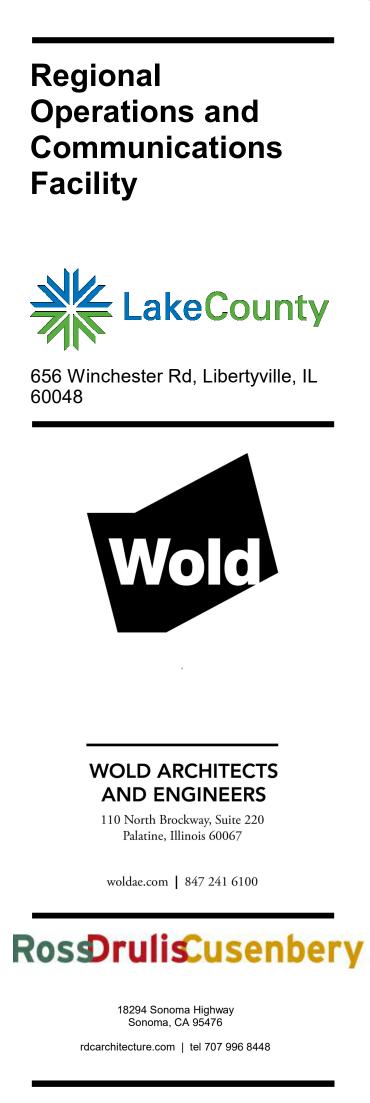
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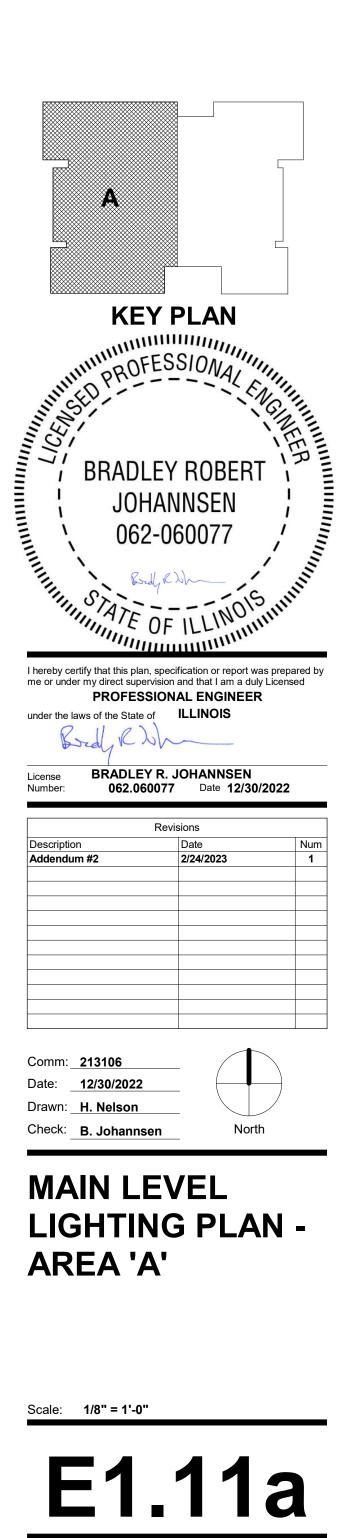
CONTRACTOR TO PROVIDE BIM CLASH DETECTION IN ACCORDANCE WITH ALL REQUIREMENTS AS INDICATED IN SEPCIFICATION SECTION 01 32 50.

KEYED SHEET NOTES

- PROVIDE 4000K COLOR TEMPERATURE FOR NORTH SIDE AND CENTER (LOBBY / ATRIUM) AREAS OF BUILDING. PROVIDE 3500K COLOR TEMPERATURE FOR OTHER AREAS AS INDICATED.
- 2. TOUCH SCREEN LIGHTING CONTROL PANEL.
- 3. INTEGRAL OCCUPANCY SENSOR.
- 4. INTEGRAL OCCUPANCY AND DAYLIGHT SENSOR. 5. PROVIDE DIMMING DAYLIGHT HARVESTING ZONE
- WITHIN DASHED LINES.
- 6. MOUNT PENDANTS BETWEEN WOOD SLATS WITH BOTTOM FLUSH TO BOTTOM OF SLATS.
- DESIGNATED STORM SHELTER. FEED EMERGENCY POWER WITHIN DASHED AREA FROM LIGHTING INVERTER.
- 8. LIGHTS TO DIM TO 50% WHEN UNOCCUPIED.
- 9. ALLOW FOR BACNET/IP LIGHTING PANEL (BY DIV 25) TO BE LOCATED IN THIS ROOM TO NETWORK ALL LIGHTING DEVICES. THE BASE PANEL DROP AND A CLIENT DROP ARE CO-LOCATED IN THIS ROOM. REFER TO BAS NOTES ON E5.02 FOR MORE INFORMATION.
- 10. LOCATE REMOTE DRIVER FOR TEAMING AREA IN ACCESSIBLE LOCATION IN MECHANICAL SPACE.
- 11. CIRCUIT CANOPY EXTERIOR LIGHTING VIA RELAY PANEL LRP1. REFER TO LIGHTING RELAY SCHEDULE. ALL EXTERIOR LIGHTS SHALL BE 4000K.
- 12. PROVIDE 2800W INVERTER FOR STORM SHELTER LIGHTING (277V) AND LOUVERS (120V). REFER TO 26 33 56 EMERGENCY LIGHTING INVERTER.
- 13. PROVIDE NETWORK LIGHTING CONTROL SYSTEM FOR WIRED CONTROL OF ALL INTERIOR LIGHTING. PROVIDE WIRELESS CONTROL OF EXTERIOR POLE LIGHTS AND RELAY CONTROL OF SELECT EXTERIOR LIGHTS AS SHOWN ON SITE PLAN. PROVIDE ALL PARS AND COMPONENTS, FIELD COORDINATE LOCATIONS AS REQUIRED.
- 14. PROVIDE LIGHTING RELAY PANEL FOR CONTROL OF SELECT EXTERIOR LIGHTS. TIE INTO NETWORK LIGHTING CONTROLS. PROVIDE NETWORKED PHOTOCELL AT BUILDING EXTERIOR AND MOUNT PER MANUFACTURER'S RECOMMENDATIONS.

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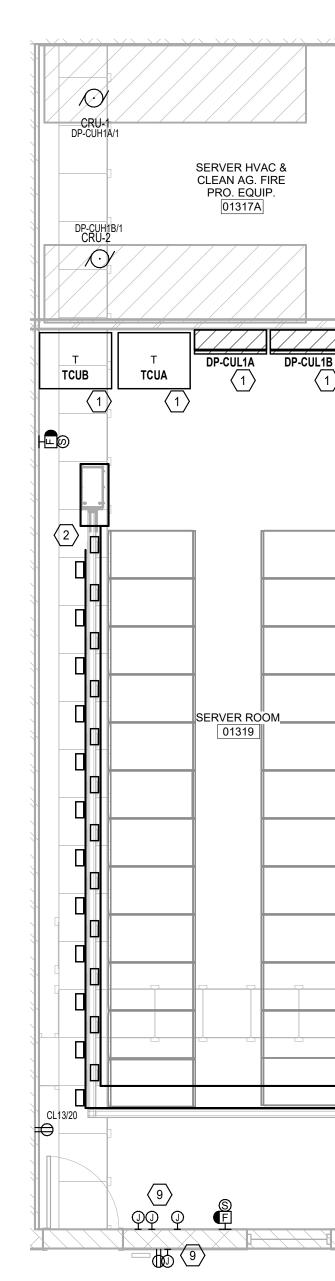
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- DISCHARGER. 6. STUB UP (4) 4" CONDUITS FROM RADIO TOWER, REFER TO SITE PLAN E0.02. ALL OUTLETS WITH DIV 27/28.
- DISTRIBUTION PANELSTO FEED BUS BAR AND UPS (DESIGNATED AS "CUL") PANELS. COORDINATE LOCATION OF OUTPUT DISTRIBUTION PANELS WITH DUCTWORK. PROVIDE STARLINE OR EQUAL 250A BUSWAY. MOUNT PARALLEL BUSWAYS IN 'U' CONFIGURATION, MOUNTED ON HOT AISLE SIDE OF RACKS. COORDINATE INSTALLATION WITH OTHER TRADES, REFER TO ARCHITECTURAL DETAILS FOR MORE INFORMATION. REFER TO BUSWAY SPECIFICATION FOR BUS PLUG DEVICE TYPES AND QUANTITIES. . PROVIDE FIRE ALARM CONNECTIONS AS REQUIRED TO DIV 21 VESDA SYSTEM. A. PROVIDE FIRE ALARM CONNECTIONS AS REQUIRED TO CLEAN AGENT SYSTEM. CONNECTIONS INCLUDE MONITORING OF TROUBLES, SUPERVISORY, ALARM AND

KEYED ELECTRICAL NOTES

PROVIDE UPS TRANSFORMER / OUTPUT

- 5. PROVIDE 120V POWER TO SECURITY EQUIPMENT.
- 7. ON WALLS WHERE PLYWOOD IS PRESENT, MOUNT ALL OUTLETS FLUSH WITH FACE OF PLYWOOD. COORDINATE EXACT LOCATION OF
- 8. PROVIDE CONDUITS FROM 911 TOWER. STUB UP ABOVE RAISED FLOOR. REFER TO SITE PLAN E0.02 FOR MORE INFORMATION.
- . PROVIDE ROUGH-IN FOR CLEAN AGENT SYSTEM SUPPLIED AND INSTALLED BY DIV 21. COORDINATE EXACT LOCATIONS, HEIGHTS AND OTHER REQUIREMENTS WITH DIV 21 CONTRACTOR.
- 10. STUB UP CAMPUS FIBER CONDUITS AT THIS LOCATION. REFER TO CAMPUS SITE PLAN E0.01 FOR MORE INFORMATION.

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D2 ENLARGED SERVER ROOM PLAN 1/4" = 1'-0"

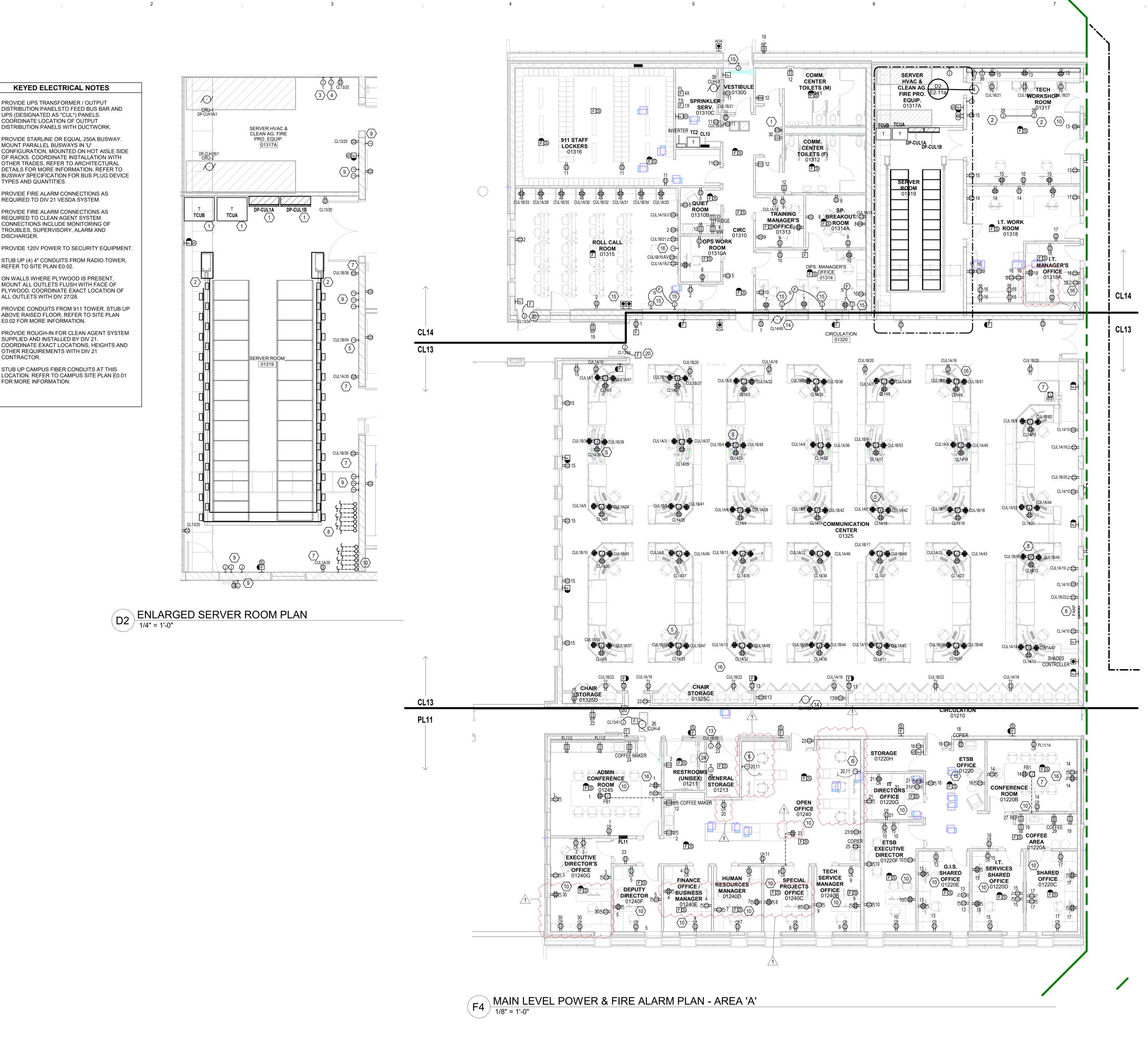
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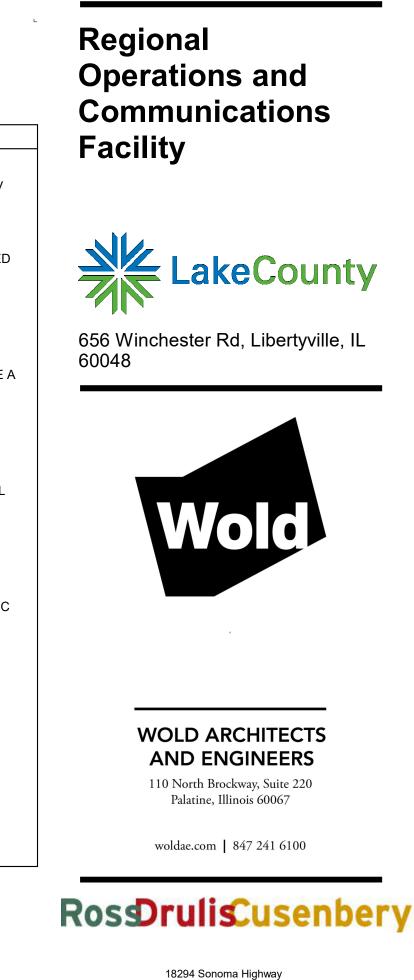


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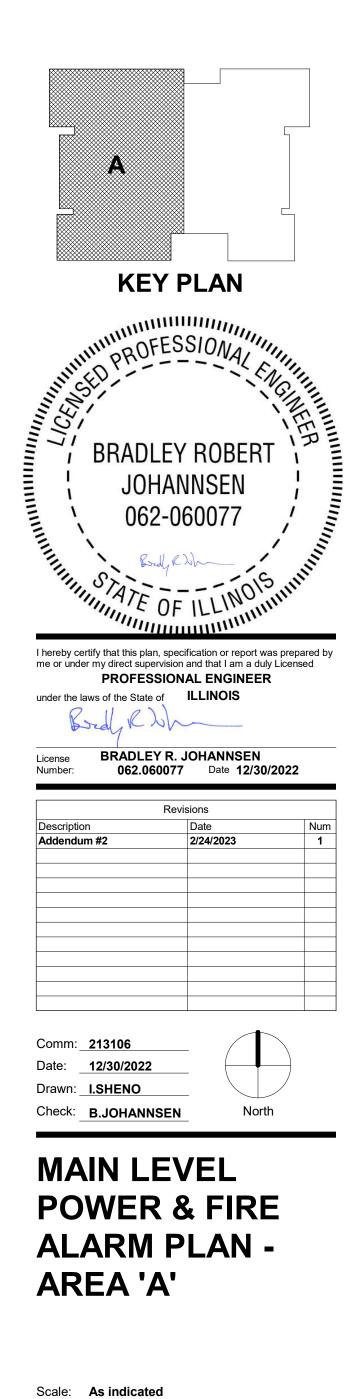
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Α.	GENERAL SHEET NOTES PROVIDE ADDITIONAL ROUGH-IN FOR SYSTEMS AS INDICATED, REFER TO TECHNOLOGY AND AV SHEETS AND ASSOCIATED DETAILS.
B.	ALL BOXES, CONDUIT AND WIRING TO BE CONCEALED. NO EXPOSED BOXES, CONDUIT AND WIRING SHALL BE ALLOWED UNLESS NOTED
C.	OTHERWISE. COORDINATE DEVICE LOCATIONS WITH OTHER TRADES INCLUDING HVAC EQUIPMENT, DUCTWORK, SPRINKLER PIPING AND BUILDING
D.	STRUCTURAL MEMBERS. NO MULTI-BRANCH CIRCUIT ALLOWED. PROVIDE A SEPARATE NEUTRAL WITH EACH CIRCUIT.
E.	VERIFY LOCATIONS AND ROUGH-IN REQUIREMENTS OF ALL OWNER FURNISHED EQUIPMENT PRIOR TO ROUGH-IN.
F.	CIRCUIT WIRING IS NOT SHOWN EXCEPT FOR SWITCHING INTENT OF FIXTURES AND CONTROL OF DEVICES.
G.	GFCI RECEPTACLES SHALL BE WIRED TO PROTECT ONLY THE DEVICES IN THAT OUTLET BOX. DOWNSTREAM DEVICES SHALL NOT BE PROTECTED BY GFCI.
H.	CIRCUIT NUMBERS SHOWN ARE FOR SCHEMATIC PURPOSES AND ARE FOR DISTINGUISHING CIRCUITS. RECORD AS-BUILT CIRCUITING IN A
I.	TYPED AND DATED PANELBOARD SCHEDULE. PROVIDE SEPARATED CONDUITS FOR ALL EMERGENCY CIRCUITS, DO NOT COMBINE WITH
J.	NORMAL BUILDING WIRING. COORDINATE HEIGHTS OF ALL DEVICES WITH MILLWORK AND MODULAR FURNITURE SHOP DRAWINGS PRIOR TO ROUGH-IN.
K.	REFER TO LAKE COUNTY CONDUIT COLOR REQUIREMENTS, SEE SYMBOL SHEET AND CONDUIT SPECIFICATIONS.
	CONTRACTOR TO PROVIDE BIM CLASH DETECTION IN ACCORDANCE WITH ALL REQUIREMENTS AS INDICATED IN
	SEPCIFICATION SECTION 01 32 50.
	KEYED SHEET NOTES
1.	PROVIDE UPSTREAM GFCI PROTECTION DEVICE
2.	FOR ELECTRIC WATER COOLER. SEE DETAIL F5/E7.01. PROVIDE RETRACTABLE CORD REEL, MOUNT IN
	JOIST SPACE. COORDINATE LOCATION WITH LIGHTING AND OTHER SYSTEMS. REFER TO 26 27
3.	26 WIRING DEVICES. ALLOW FOR BACNET/IP FIRE ALARM PANEL TO BE LOCATED IN THIS ROOM TO NETWORK ALL FIRE
	ALARM DEVICES. THE BASE PANEL DROP AND A CLIENT DROP ARE CO-LOCATED IN THIS ROOM.
4.	REFER TO BAS NOTES ON E5.02 FOR MORE INFORMATION. PROVIDE DUAL CHANNEL SURFACE RACEWAY
	ABOVE WORKBENCH AND ALSO ABOVE SHELVING, WITH SIMPLEX OUTLETS ON 8-INCH CENTERS. REFER TO SYSTEMS PLANS FOR DATA
5.	REQUIREMENTS. PROVIDE POWER CONNECTIONS TO DISPATCH
	FURNITURE. PROVIDE RECESSED RAISED FLOOR BOX TYPE RFB3 (REFER TO FLOOR BOX SCHEDULE). ROUTE UNDERFLOOR POWER VIA
	CONDUIT AND CONNECT TO BOX VIA WHIP. COORDINATE EXACT LOCATIONS OF BOXES WITH
	FINAL FURNITURE LAYOUT. PROVIDE INFRASTRUCTURE AS REQUIRED FOR DATA CABLING AND DEVICES, REFER TO SIGNAL
6.	PLANS. PROVIDE WHIP AND POWER CONNECTION TO
	FURNITURE WITH 50% PREWIRED CONTROLLED OUTLETS. PROVIDE TWO SEPARATE POWER CONNECTIONS, ONE TIED TO LIGHTING
7.	OCCUPANCY SENSOR.
8.	COORDINATE EXACT LOCATIONS OF SYSTEM STATUS EQUIPMENT AT DISPATCH MANAGER'S
	STATION. EQUIPMENT INCLUDES ANNUNCIATORS FOR GENERATOR, TRANSFER SWITCHES, UPS AND FIRE ALARM.
9. 10	
τU	OUTLETS (DESIGNATED BY "CR"). UTILIZE OCCUAPNCY SENSOR CONTROLLING LIGHTS
11	THIS AREA. REFER TO CONTROLLED OUTLET DETAIL. . REFER TO BAS NOTES ON E5.02 FOR MORE
	INFORMATION PERTAINING TO ELECTRICAL DISTRIBUTION EQUIPMENT . . PROVIDE OUTLETS AS REQUIRED FOR VIDEO
١Z	WALL. WALL CONTAINS 8x3 GRID OF (24) MONITORS. PROVIDE OUTLET FOR EACH
	MONITOR, SIX OUTLETS PER CIRCUIT, WIRE SUCH THAT COLUMNS ARE ON ALTERNATING UPS PANEL (A/B/A/B/A/B/A/B).
	 PROVIDE HARDWIRED CONNECTION FOR BAS EQUIPMENT. PROVIDE ELECTRICAL CONNECTION TO
14	MECHOSHADES AS REQUIRED. REFER TO ARCHITECTURAL CLERESTORY MEZZANINE PLAN
	FOR EXACT LENGTH AND LOCATIONS. PROVIDE ROUGH-IN AND CABLING FOR ROOM WALL CONTROLS BY DIV 12.
15	. PROVIDE 120V POWER FROM STORM SHELTER INVERTER TO MOTORIZED LOUVER / COILING
	DOOR. PROVIDE RACEWAY AND BOXES FOR RELEASE BUTTON CONTROLS LOCATED IN ROLL CALL 01315. WHERE SMOKE DETECTORS ARE
	INDICATED, PROVIDE FIRE ALARM INTERCONNECTION TO AUTOMATICALLY RELEASE EQUIPMENT.
16	. PROVIDE 16" X 16" RECESSED TV BOX AND MOUNT RECEPTACLE WITHIN. CHIEF PAC526F OR
	EQUAL. TYPICAL ALL TV OUTLETS. COORDINATE EXACT HEIGHT/LOCATION WITH ARCHITECTURAL ELEVATIONS AND AV EQUIPMENT SUPPLIER.
17	. UPS SYSTEM. BASE BID: PROVIDE 30 MINUTE BATTERY. ALTERNATE #1 (DEDUCT): PROVIDE 20 MINUTE BATTERY.
18	. PROVIDE 4"X4" JUNCTION BOX AT 18" AFF WITH 1-1/4" CONDUIT TO ACCESSIBLE CEILING SPACE
	FOR AV CABLING. PROVIDE (2) 120V CONNECTIONS AT AHU (FOR UV LIGHTS AND AUXILLIARY EQUIPMENT).
	 PROVIDE 120V POWER AND FIRE ALARM MODULE AT DELAYED EGRESS DOOR. PROVIDE 120V CONNECTION TO FIRE PUMP AND
	JOCKEY PUMP CONTROL PANELS. . PROVIDE 120V AND FIRE ALARM CONNECTION TO
23	PREACTION PANEL AS REQUIRED. PROVIDE 120V CONNECTION TO NITROGEN GENERATOR. PROVIDE ADDITIONAL CONDUIT
	AND FIRE ALARM CONNECTIONS AS REQUIRED. REFER TO DRY TYPE SYSTEM DETAIL.

AND FIRE ALARM CONNECTIONS AS REQUIRED REFER TO DRY TYPE SYSTEM DETAIL. 24. PROVIDE DEDICATED CIRCUIT FOR SOUND MASKING EQUIPMENT. COORDINATE EXACT LOCATION AND REQUIREMENTS WITH DIV 27. 25. PROVIDE WHIP AND POWER CONNECTION TO FURNITURE AS INDICATED.

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18294 Sonoma Highway Sonoma, CA 95476 rdcarchitecture.com | tel 707 996 8448





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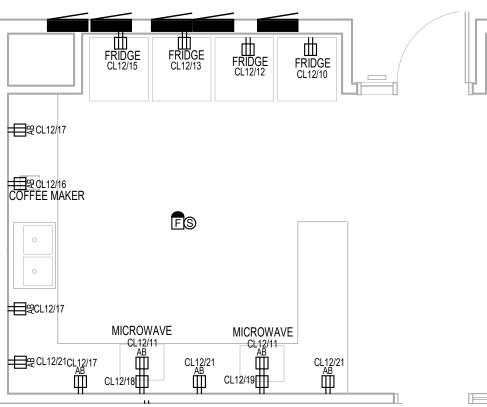
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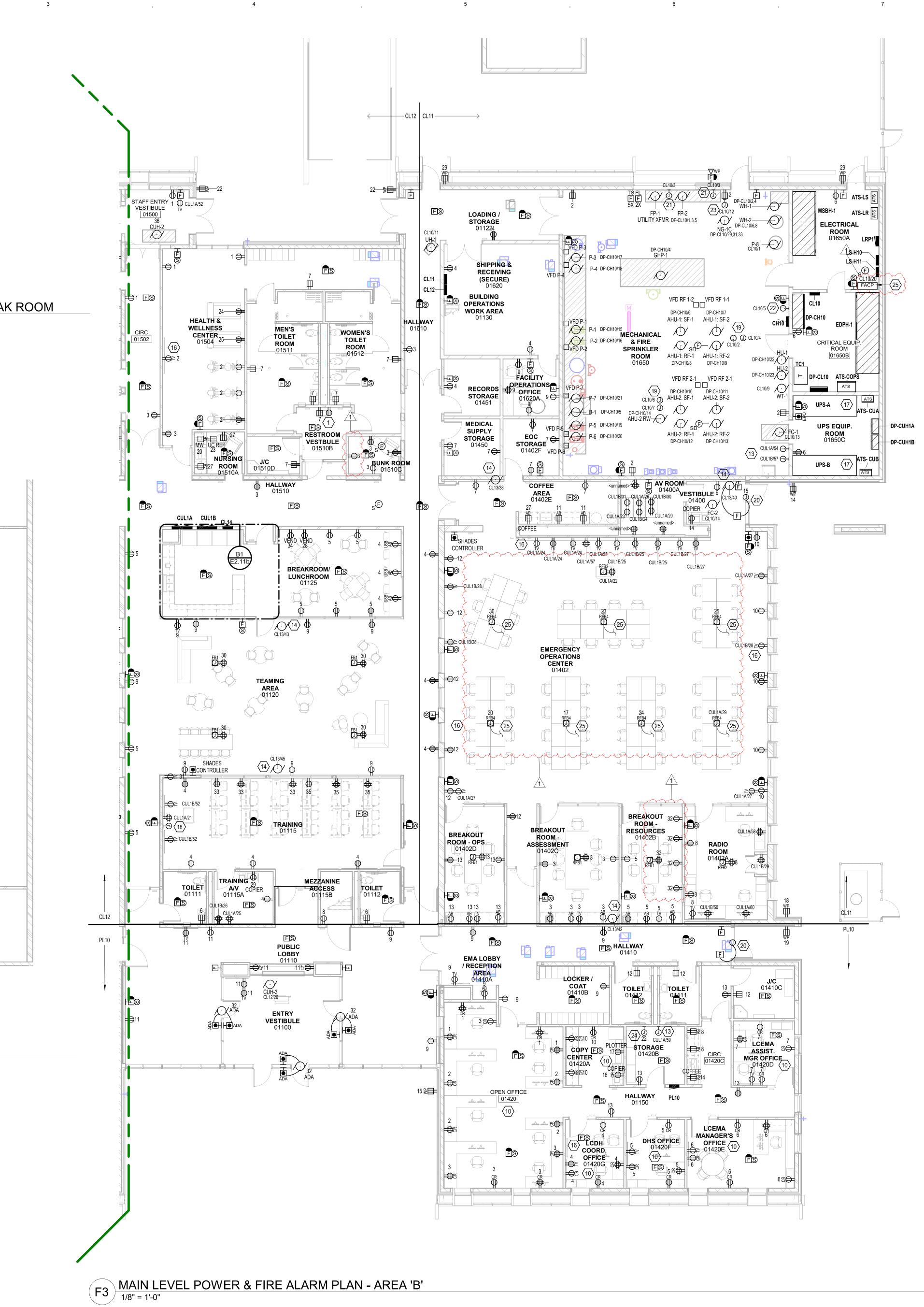
E1 MEZZANINE LEVEL POWER & FIRE ALARM PLAN

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B1 MAIN LEVEL POWER & FIRE ALARM PLAN - BREAK ROOM



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GENERAL SHEET NOTES A. PROVIDE ADDITIONAL ROUGH-IN FOR SYSTEMS AS INDICATED, REFER TO TECHNOLOGY AND AV SHEETS AND ASSOCIATED DETAILS. B. ALL BOXES, CONDUIT AND WIRING TO BE CONCEALED. NO EXPOSED BOXES, CONDUIT AND WIRING SHALL BE ALLOWED UNLESS NOTED OTHERWISE. C. COORDINATE DEVICE LOCATIONS WITH OTHER TRADES INCLUDING HVAC EQUIPMENT, DUCTWORK, SPRINKLER PIPING AND BUILDING STRUCTURAL MEMBERS. D. NO MULTI-BRANCH CIRCUIT ALLOWED. PROVIDE A SEPARATE NEUTRAL WITH EACH CIRCUIT. VERIFY LOCATIONS AND ROUGH-IN REQUIREMENTS OF ALL OWNER FURNISHED EQUIPMENT PRIOR TO ROUGH-IN. F. CIRCUIT WIRING IS NOT SHOWN EXCEPT FOR SWITCHING INTENT OF FIXTURES AND CONTROL OF DEVICES. G. GFCI RECEPTACLES SHALL BE WIRED TO PROTECT ONLY THE DEVICES IN THAT OUTLET BOX. DOWNSTREAM DEVICES SHALL NOT BE PROTECTED BY GFCI. H. CIRCUIT NUMBERS SHOWN ARE FOR SCHEMATIC PURPOSES AND ARE FOR DISTINGUISHING CIRCUITS. RECORD AS-BUILT CIRCUITING IN A TYPED AND DATED PANELBOARD SCHEDULE. PROVIDE SEPARATED CONDUITS FOR ALL EMERGENCY CIRCUITS, DO NOT COMBINE WITH NORMAL BUILDING WIRING.

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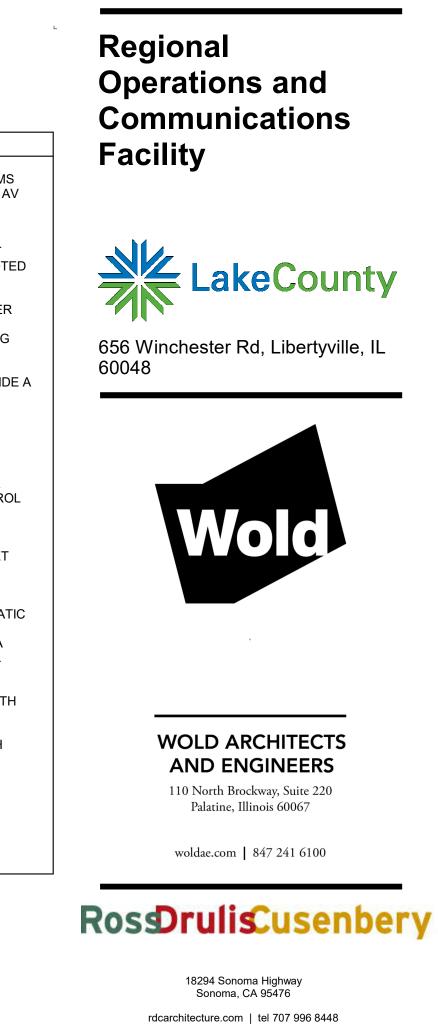
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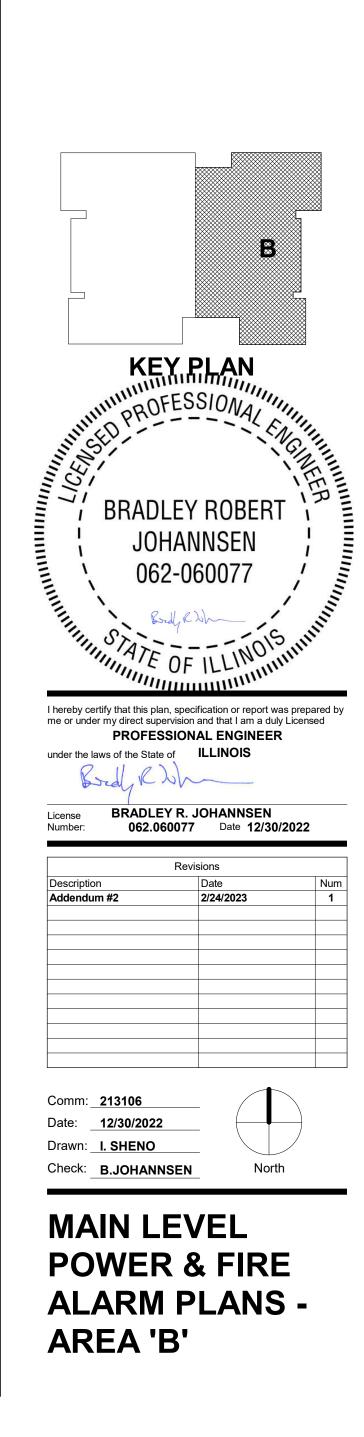
- I. COORDINATE HEIGHTS OF ALL DEVICES WITH MILLWORK AND MODULAR FURNITURE SHOP DRAWINGS PRIOR TO ROUGH-IN.
- K. REFER TO LAKE COUNTY CONDUIT COLOR REQUIREMENTS, SEE SYMBOL SHEET AND CONDUIT SPECIFICATIONS.

CONTRACTOR TO PROVIDE BIM CLASH DETECTION IN ACCORDANCE WITH ALL REQUIREMENTS AS INDICATED IN SEPCIFICATION SECTION 01 32 50.

\bigcirc	KEYED SHEET NOTES
1.	PROVIDE UPSTREAM GFCI PROTECTION DEVICE FOR ELECTRIC WATER COOLER. SEE DETAIL
2.	F5/E7.01. PROVIDE RETRACTABLE CORD REEL, MOUNT IN JOIST SPACE. COORDINATE LOCATION WITH LIGHTING AND OTHER SYSTEMS. REFER TO 26 27
3.	26 WIRING DEVICES. ALLOW FOR BACNET/IP FIRE ALARM PANEL TO BE LOCATED IN THIS ROOM TO NETWORK ALL FIRE
	ALARM DEVICES. THE BASE PANEL DROP AND A CLIENT DROP ARE CO-LOCATED IN THIS ROOM. REFER TO BAS NOTES ON E5.02 FOR MORE INFORMATION.
4.	PROVIDE DUAL CHANNEL SURFACE RACEWAY ABOVE WORKBENCH AND ALSO ABOVE SHELVING, WITH SIMPLEX OUTLETS ON 8-INCH CENTERS. REFER TO SYSTEMS PLANS FOR DATA
5.	REQUIREMENTS. PROVIDE POWER CONNECTIONS TO DISPATCH FURNITURE. PROVIDE RECESSED RAISED FLOOR BOX TYPE RFB3 (REFER TO FLOOR BOX
	SCHEDULE). ROUTE UNDERFLOOR POWER VIA CONDUIT AND CONNECT TO BOX VIA WHIP. COORDINATE EXACT LOCATIONS OF BOXES WITH FINAL FURNITURE LAYOUT. PROVIDE
	INFRASTRUCTURE AS REQUIRED FOR DATA CABLING AND DEVICES, REFER TO SIGNAL PLANS.
6.	PROVIDE WHIP AND POWER CONNECTION TO FURNITURE WITH 50% PREWIRED CONTROLLED OUTLETS. PROVIDE TWO SEPARATE POWER CONNECTIONS, ONE TIED TO LIGHTING
7.	OCCUPANCY SENSOR. PROVIDE FLOOR BOX, REFER TO FLOOR BOX
8.	SCHEDULE FOR MORE INFORMATION. COORDINATE EXACT LOCATIONS OF SYSTEM STATUS EQUIPMENT AT DISPATCH MANAGER'S STATION. EQUIPMENT INCLUDES ANNUNCIATORS FOR GENERATOR, TRANSFER SWITCHES, UPS
9.	AND FIRE ALARM. FIRE PUMP, PROVIDE FIRE ALARM CONNECTIONS AS REQUIRED.
10.	PROVIDE PLUG LOAD CONTROL OF SPLIT OUTLETS (DESIGNATED BY "CR"). UTILIZE OCCUAPNCY SENSOR CONTROLLING LIGHTS THIS AREA. REFER TO CONTROLLED OUTLET
11.	DETAIL. REFER TO BAS NOTES ON E5.02 FOR MORE INFORMATION PERTAINING TO ELECTRICAL
12.	DISTRIBUTION EQUIPMENT . PROVIDE OUTLETS AS REQUIRED FOR VIDEO WALL. WALL CONTAINS 8x3 GRID OF (24) MONITORS. PROVIDE OUTLET FOR EACH MONITOR, SIX OUTLETS PER CIRCUIT, WIRE
	SUCH THAT COLUMNS ARE ON ALTERNATING UPS PANEL (A/B/A/B/A/B/A/B).
	PROVIDE HARDWIRED CONNECTION FOR BAS EQUIPMENT.
14.	PROVIDE ELECTRICAL CONNECTION TO MECHOSHADES AS REQUIRED. REFER TO ARCHITECTURAL CLERESTORY MEZZANINE PLAN FOR EXACT LENGTH AND LOCATIONS. PROVIDE ROUGH-IN AND CABLING FOR ROOM WALL
15.	CONTROLS BY DIV 12. PROVIDE 120V POWER FROM STORM SHELTER INVERTER TO MOTORIZED LOUVER / COILING DOOR. PROVIDE RACEWAY AND BOXES FOR
	RELEASE BUTTON CONTROLS LOCATED IN ROLL CALL 01315. WHERE SMOKE DETECTORS ARE INDICATED, PROVIDE FIRE ALARM INTERCONNECTION TO AUTOMATICALLY RELEASE EQUIPMENT.
16.	PROVIDE 16" X 16" RECESSED TV BOX AND MOUNT RECEPTACLE WITHIN. CHIEF PAC526F OR EQUAL. TYPICAL ALL TV OUTLETS. COORDINATE EXACT HEIGHT/LOCATION WITH ARCHITECTURAL
17.	ELEVATIONS AND AV EQUIPMENT SUPPLIER. UPS SYSTEM. BASE BID: PROVIDE 30 MINUTE BATTERY. ALTERNATE #1 (DEDUCT): PROVIDE 20 MINUTE BATTERY.
	PROVIDE 4"X4" JUNCTION BOX AT 18" AFF WITH 1-1/4" CONDUIT TO ACCESSIBLE CEILING SPACE FOR AV CABLING.
	PROVIDE (2) 120V CONNECTIONS AT AHU (FOR UV LIGHTS AND AUXILLIARY EQUIPMENT).
	PROVIDE 120V POWER AND FIRE ALARM MODULE AT DELAYED EGRESS DOOR.
	PROVIDE 120V CONNECTION TO FIRE PUMP AND JOCKEY PUMP CONTROL PANELS. PROVIDE 120V AND FIRE ALARM CONNECTION TO
	PROVIDE 120V AND FIRE ALARM CONNECTION TO PREACTION PANEL AS REQUIRED. PROVIDE 120V CONNECTION TO NITROGEN
	GENERATOR. PROVIDE ADDITIONAL CONDUIT AND FIRE ALARM CONNECTIONS AS REQUIRED. REFER TO DRY TYPE SYSTEM DETAIL.
	PROVIDE DEDICATED CIRCUIT FOR SOUND MASKING EQUIPMENT. COORDINATE EXACT LOCATION AND REQUIREMENTS WITH DIV 27.
25.	PROVIDE WHIP AND POWER CONNECTION TO FURNITURE AS INDICATED.

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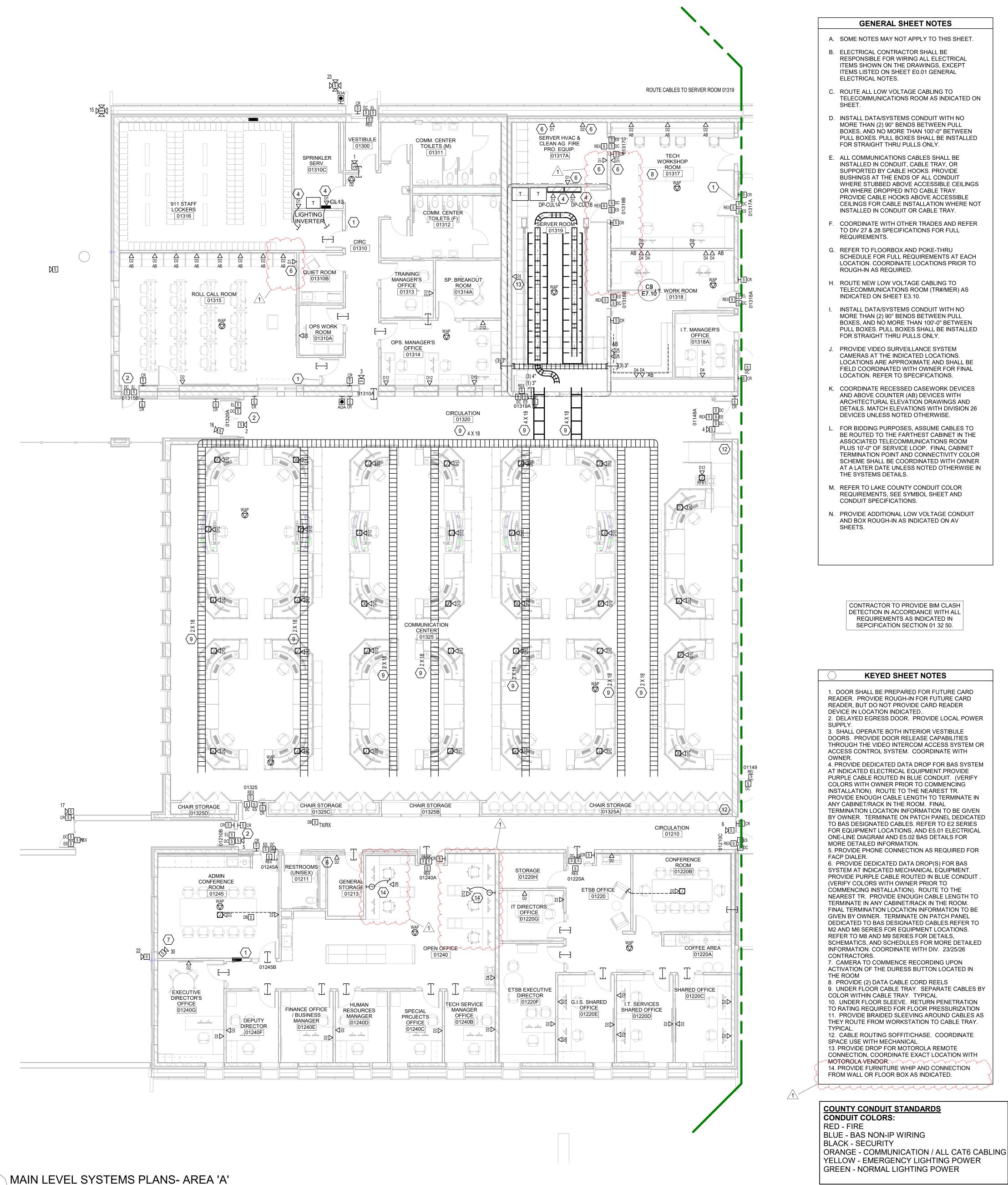
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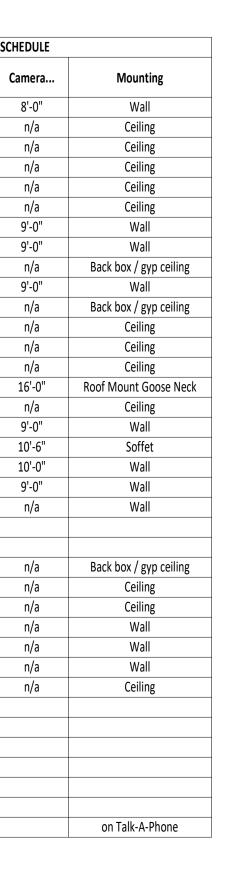
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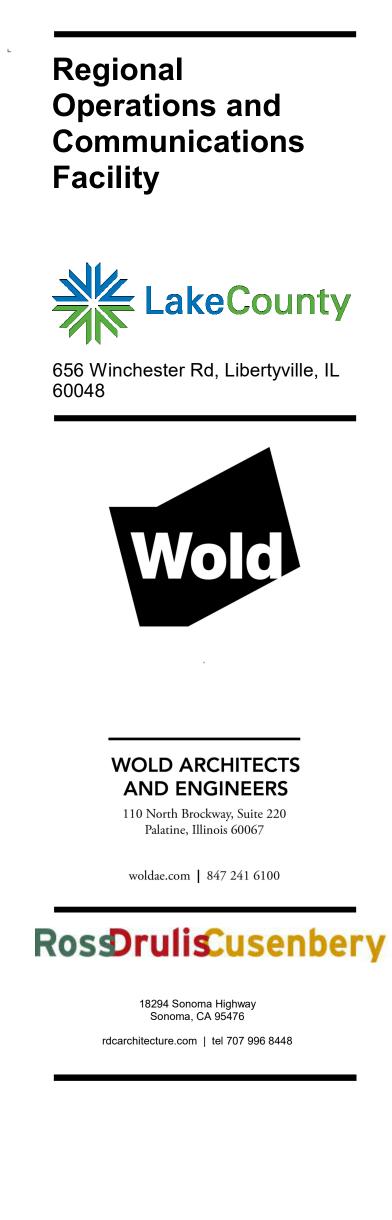
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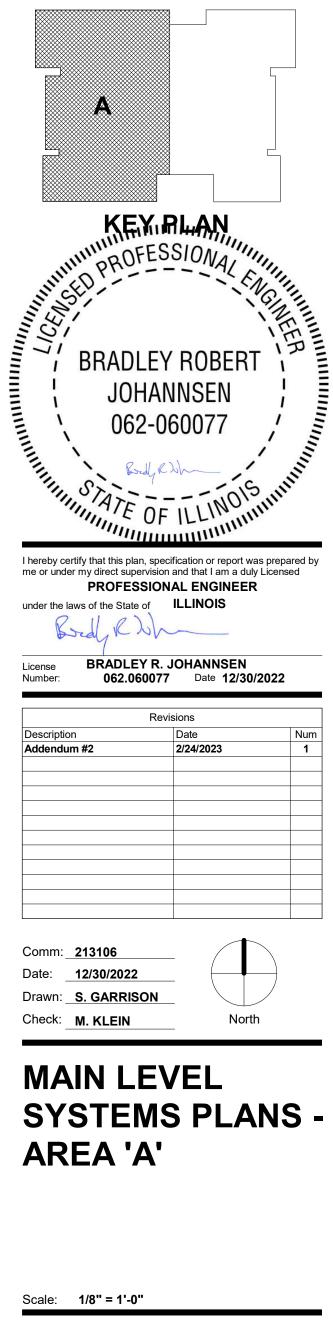
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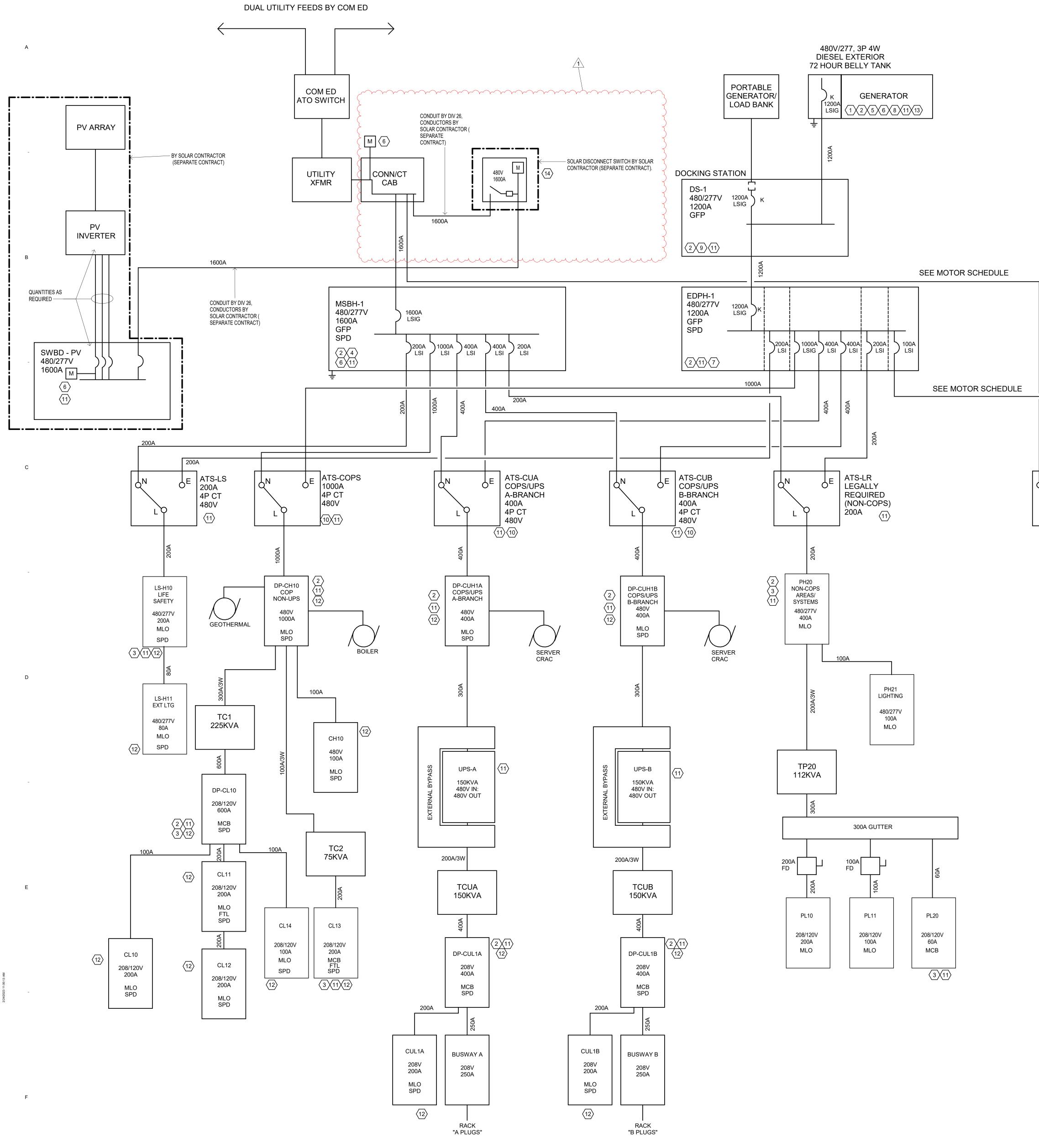


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F1 ONELINE DIAGRAM

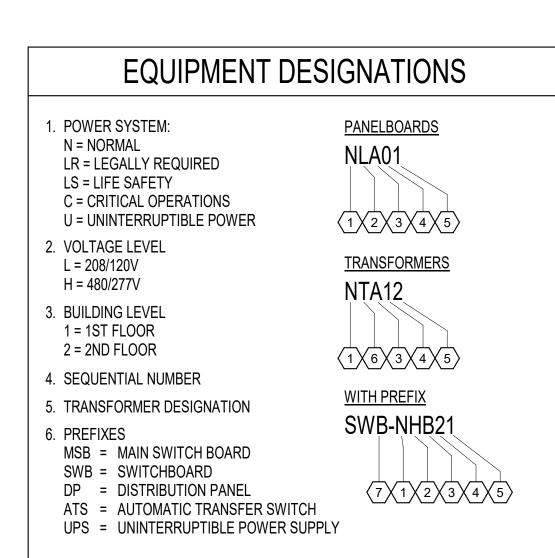
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FIRE PUMP

(BY DIV 21)

FIRE PUMP

CONTROLLER

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GENERAL NOTES:

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A. PROVIDE XHHW INSULATION FOR UNDERGROUND CONDUCTORS.

I.

B. PROVIDE GALVANIZED RIGID STEEL CONDUIT FOR EXPOSED EXTERIOR CONDUITS C. ROUTE HORIZONTAL CONDUITS ABOVE BOTTOM CHORD OF BAR JOISTS UNLESS NOTED OTHERWISE. ROUTE CONDUITS FROM WALL MOUNTED DEVICES VERTICALLY TO JOIST SPACE UNLESS NOTED OTHERWISE.

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- D. OBTAIN SHOP DRAWINGS OF EQUIPMENT AND COMPARE CONNECTION, LOAD, AND VOLTAGE INFORMATION TO CONTRACT DOCUMENTS BEFORE INSTALLING FEEDER CONDUITS. NOTIFY ARCHITECT OF ANY DISCREPANCIES. BEFORE MAKING EQUIPMENT POWER CONNECTIONS, COMPARE EQUIPMENT NAMEPLATE DATA TO SHOP DRAWINGS AND CONTRACT DOCUMENTS. NOTIFY ARCHITECT OF ANY DISCREPANCIES.
- E. MOTOR FEEDERS SHOWN ON DIAGRAM FOR REFERENCE. REFER TO MOTOR SCHEDULE FOR MORE INFORMATION.
- F. REFER TO SITE PLAN FOR EXACT LOCATIONS OF EXTERIOR EQUIPMENT.
- G. REFER TO GROUNDING SHEETS AND DETAILS FOR ADDITIONAL INFORMATION.
- H. PROVIDE CONCRETE BASES FOR ALL FLOOR MOUNTED EQUIPMENT.

KEYED NOTES:

SPECIFICATIONS.

YARD.

- 1. PROVIDE 1" CONDUIT WITH CONTROL WIRING FROM GENERATOR TO EACH ATS. COORDINATE EXACT REQUIREMENTS WITH ATS AND GENERATOR MANUFACTURER.
- 2. PROVIDE EQUIPMENT WITH LSIG BREAKERS (800A AND ABOVE) AND LSI BREAKERS (100A TO 600A). INCLUDE METERING AND BACNET PROVISIONS WITH EACH SUCH BREAKER. METERING REQUIRED TO MEET REQUIREMENTS OF LEED V4. METERING DATA IS AGGREGATED BY DIV 25 BAS. REFER TO EQUIPMENT AND METERING SCHEDULES FOR MORE DETAILED INFORMATION.
- 3. PROVIDE BRANCH CIRCUIT METERING WHERE INDICATED ON EQUIPMENT SCHEDULES. 4. PROVIDE WITH OWNER SWITCHBOARD LEVEL OWNER-METERING, REFER TO
- 5. PROVIDE RAISED PLATFORM WITH RAILING AND STAIRS IN FRONT OF CONTROL PANEL. COORDINATE LOCATION WITH CLEARANCES OF OTHER EQUIPMENT IN EQUIPMENT
- 6. PROVIDE METERING IN MANNER INDICATED ON METERING MATRIX, SEE SHEET E5.02. REFER TO EQUIPMENT AND METERING SPECIFICATIONS AND BAS NOTES ON SHEET E5.02 FOR ADDITIONAL METERING INFORMATION.
- 7. PROVIDE SEPARATE VERTICAL SECTIONS FOR LIFE SAFETY, COPS, LEGALLY REQUIRED, AND FIRE PUMP. 8. PROVIDE 208V/1PH 60A CONNECTION FROM PANEL CL10 FOR GENERATOR LOAD
- CENTER. GENERATOR ACCESSORIES FED FROM LOAD CENTER. COORDINATE EXACT LOCATION OF GENERATOR REMOTE SHUT OFF WITH OWNER PRIOR TO ROUGH-IN. VERIFY AMPACITY OF LOAD CENTER PRIOR TO CONDUIT ROUGH-IN. 9. PROVIDE DOCKING STATION WITH CAM LOCKS FOR BOTH PORTABLE GENERATOR AND
- PORTABLE LOAD BANK. PROVIDE KIRK KEY BREAKER AND INTERLOCK WITH KIRK KEYS AT GENERATOR AND EMERGENCY SWITCHBOARD. PROVIDE SHORE POWER OUTLETS FED FROM PANEL CL10 AS NOTED ON SITE PLAN. VERIFY SHORE POWER AMPACITIES WITH COUNTY PRIOR TO ROUGH-IN.
- 10. REFER TO RACEWAY AND BOXES SPECIFICATIONS FOR HARDENING REQUIREMENTS RELATED TO COPS/DCOA AREA. REFER TO E0.04 OVERALL PLAN FOR DCOA BOUNDARY DEFINITION. TYPICAL FOR ALL EQUIPMENT WITHIN DCOA AREA.
- 11. CONTRACTOR TO DAISY CHAIN MODBUS OR PROPRIETARY NETWORK CABLE FROM THE TRIP UNITS AND/OR BRANCH CIRCUIT METERING IN THE SWITCHBOARD TO THE BACNET INTERFACE DEVICE. THE COMMS WIRING ARRANGEMENT IN THE SWITCHBOARD WILL BE REVIEWED AS PART OF THE COMPARTMENTATION REVIEW SHOWING THE SEPARATE 480, 208, 120 AND 24 V RUNS. PROVIDE A SEPARATE LOW VOLTAGE (120 V) ENCLOSURE FOR BACNET INTERFACE DEVICE(S). REFER TO BAS NOTES ON SHEET E0.04 FOR MORE INFORMATION. REFER TO BAS NOTES ON SHEET E5.02 FOR MORE INFORMATION.
- 12. PROVIDE SURGE PROTECTION DEVICE WITH AUXILIARY CONTACT. REFER TO BAS NOTES ON SHEET E5.02 FOR MORE INFORMATION.
- 13. PROVIDE ANNUNCIATORS FOR GENERATOR, TRANSFER SWITCHES AND UPS'S IN DISPTACH. REFER TO POWER PLANS FOR LOCATIONS. 14. BACNET COMPATIBLE METER PROVIDED BY SOLAR CONTRACTOR (SEPARATE

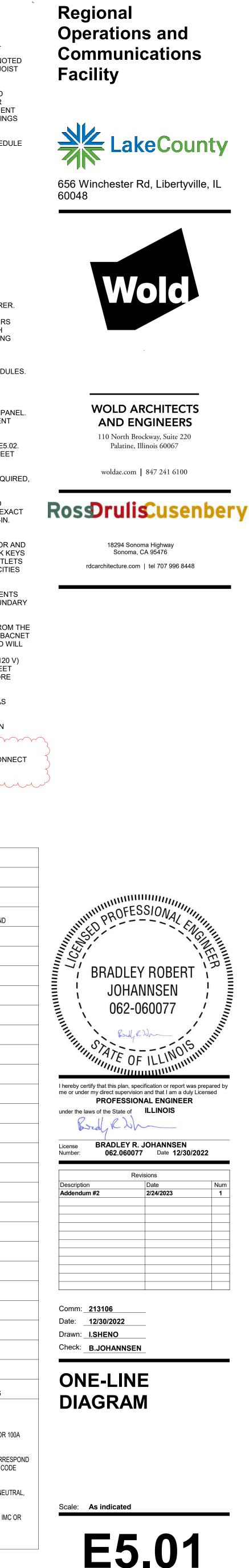
CONTRACT). PROVIDE CONDUIT AND BACNET CONNECTION FROM SOLAR DISCONNECT TO BUILDING AS REQUIRED.

UND G G G	FEEDER 4W (WITH NEUTRAL) CONDUIT-PHASE-GROU (1) 1/2"C, 4#12+1#12G (1) 3/4"C, 4#10+1#10G (1) 3/4"C, 4#8+1#10G
G G G	CONDUIT-PHASE-GROU (1) 1/2"C, 4#12+1#12G (1) 3/4"C, 4#10+1#10G
G G G	(1) 1/2"C, 4#12+1#12G (1) 3/4"C, 4#10+1#10G
G	(1) 3/4"C, 4#10+1#10G
3	
	(1) 3/4"C. 4#8+1#10G
	(<i>j j j</i>
	(1) 1"C, 4#6+1#10G
3	(1) 1.25"C, 4#4+1#8G
3	(1) 1.25"C, 4#3+1#8G
i	(1) 1.5"C, 4#1+1#6G
i	(1) 1.5"C, 4#1+1#6G
G	(1) 1.5"C, 4#1/0+1#6G
G	(1) 2"C, 4#2/0+1#6G
i	(1) 2"C, 4#3/0+1#6G
	(1) 2.5"C, 4#4/0+1#4G
3	(1) 2.5"C, 4#250+1#4G
G	(1) 3"C, 4#350+1#4G
	(2) 2"C, 4#3/0+1#3G
3	(2) 2.5"C, 4#250+1#2G
G	(2) 3"C, 4#350+1#1G
)G	(3) 2.5"C, 4#300+1#1/00
G	(3) 3"C, 4#400+1#2/0G
G	(4) 3"C, 4#350+1#3/0G
G	(5) 3"C, 4#400+1#4/0G
G	(6) 3"C, 4#400+1#250G
G	(7) 3"C, 4#500+1#350G
G	(8) 3.5"C, 4#500+1#4000
0	DG DG DG DG TYPICAL FEEDERS AND S 0-15 OF THE NEC FOR CC R 125A AND ABOVE. DICATE FEEDER AMPACIT

D. WHERE PARALLEL CONDUITS ARE INDICATED FOR A SINGLE FEEDER, EACH CONDUIT SHALL CONTAIN PHASE, NEUTRAL AND GROUND CONDUCTORS INDICATED. E. CONDUIT ABOVE GRADE INDOORS SHALL BE EMT. CONDUIT ABOVE GRADE OUTDOORS SHALL BE GALVANIZED IMC OR

F. EMT USED FOR PURPOSES OF SIZING CONDUIT. CONTRACTOR TO UPSIZE CONDUIT IF DIFFERENT THAN EMT.

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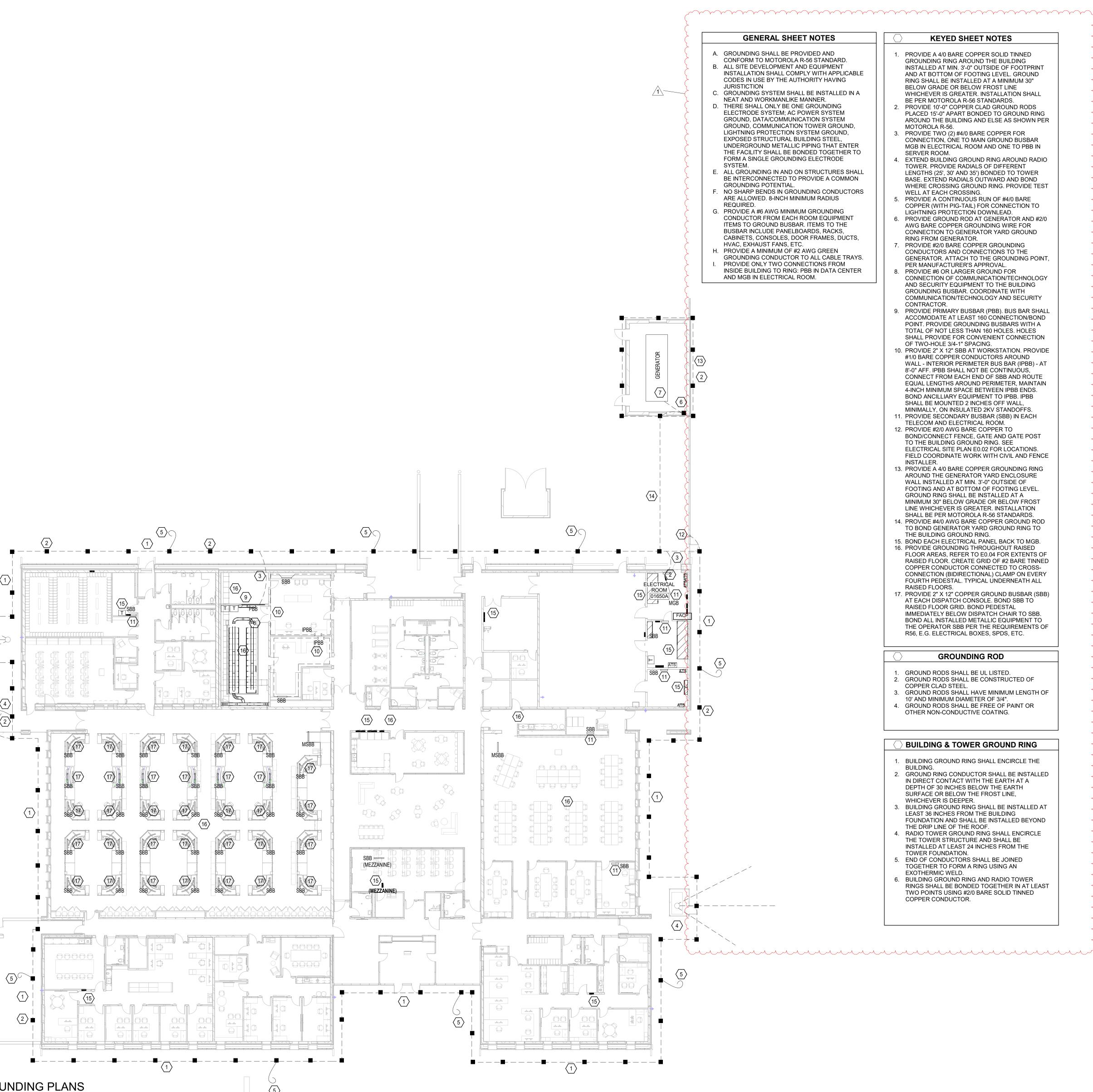
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F3 GROUNDING PLANS

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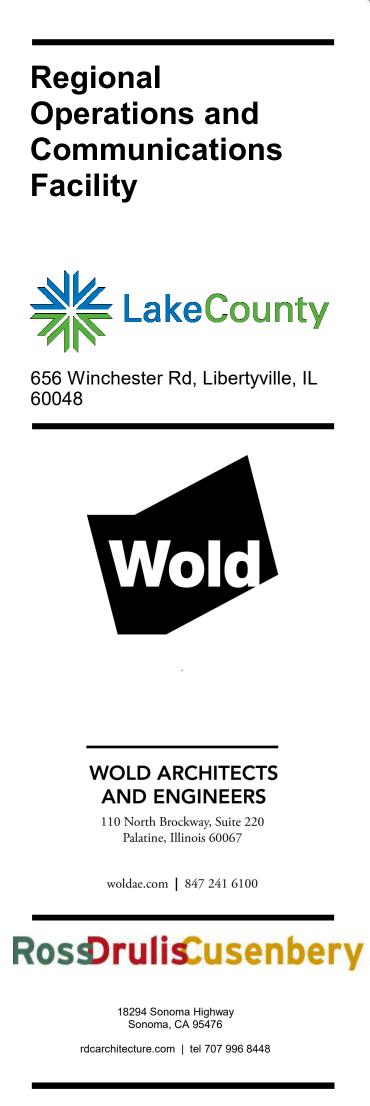


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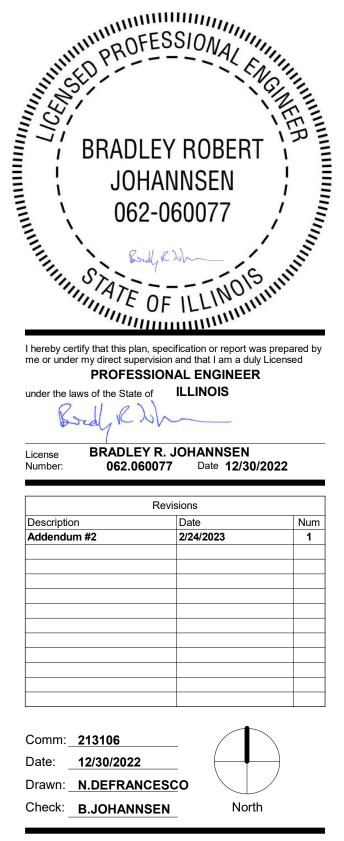
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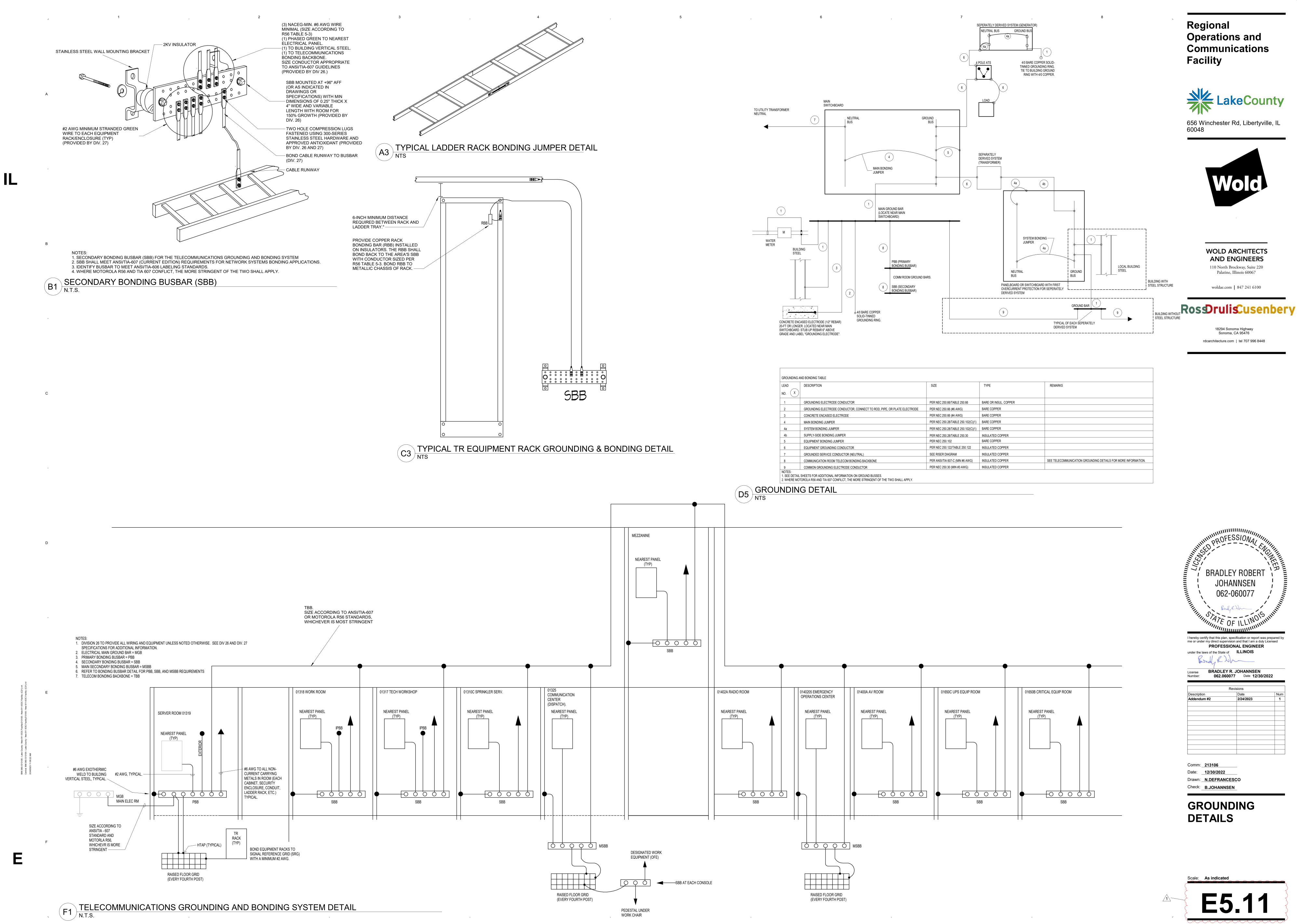
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Scale: As indicated

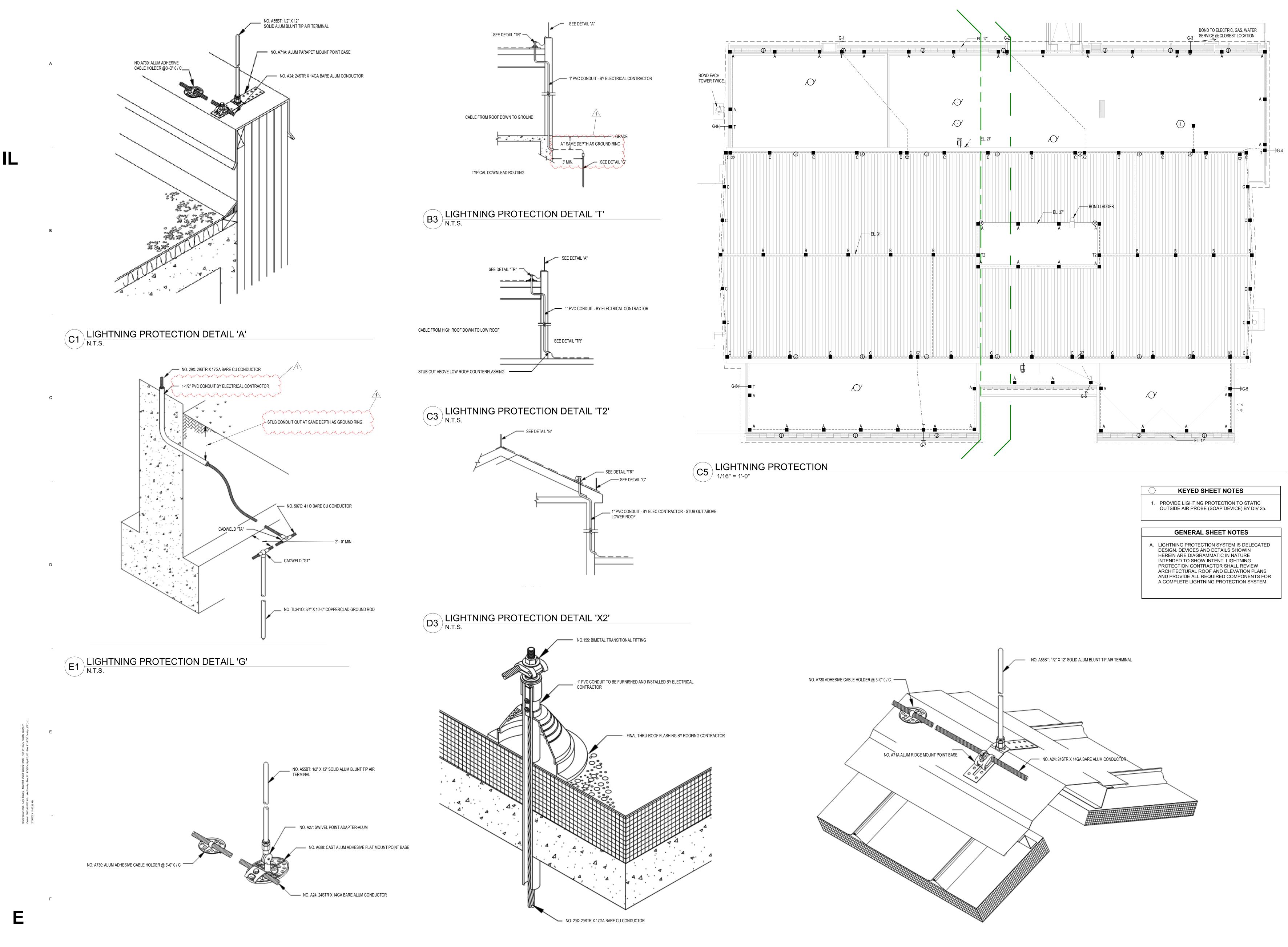
E5.10



EAD	DESCRIPTION	SIZE	ТҮРЕ	REMARKS
0. X				
1	GROUNDING ELECTRODE CONDUCTOR	PER NEC 250.66/TABLE 250.66	BARE OR INSUL. COPPER	
2	GROUNDING ELECTRODE CONDUCTOR, CONNECT TO ROD, PIPE, OR PLATE ELECTRODE	PER NEC 250.66 (#6 AWG)	BARE COPPER	
3	CONCRETE ENCASED ELECTRODE	PER NEC 250.66 (#4 AWG)	BARE COPPER	
4	MAIN BONDING JUMPER	PER NEC 250.28/TABLE 250.102(C)(1)	BARE COPPER	
4a	SYSTEM BONDING JUMPER	PER NEC 250.28/TABLE 250.102(C)(1)	BARE COPPER	
4b	SUPPLY-SIDE BONDING JUMPER	PER NEC 250.28/TABLE 250.30	INSULATED COPPER	
5	EQUIPMENT BONDING JUMPER	PER NEC 250.102	BARE COPPER	
6	EQUIPMENT GROUNDING CONDUCTOR	PER NEC 250.122/TABLE 250.122	INSULATED COPPER	
7	GROUNDED SERVICE CONDUCTOR (NEUTRAL)	SEE RISER DIAGRAM	INSULATED COPPER	
8	COMMUNICATION ROOM TELECOM BONDING BACKBONE	PER ANSI/TIA 607-C (MIN #6 AWG)	INSULATED COPPER	SEE TELECOMMUNICATION GROUNDING DETAILS FOR MORE INFORMATION
9	COMMON GROUNDING ELECTRODE CONDUCTOR	PER NEC 250.30 (MIN #3 AWG)	INSULATED COPPER	
	SHEETS FOR ADDITIONAL INFORMATION ON GROUND BUSSES. TOROLA R56 AND TIA 607 CONFILCT, THE MORE STRINGENT OF THE TWO SHALL APPLY.			

License	BRADLEY R. JO	DHANNSEN
Number:	062.060077	Date 12/30/2022

	Revisions	
Description	Date	Num
Addendum #2	2/24/2023	1



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F1 LIGHTNING PROTECTION DETAIL 'C'

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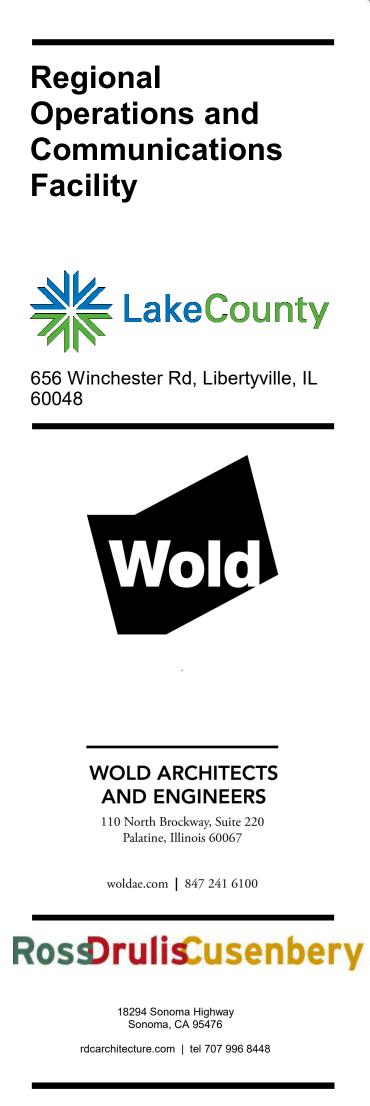
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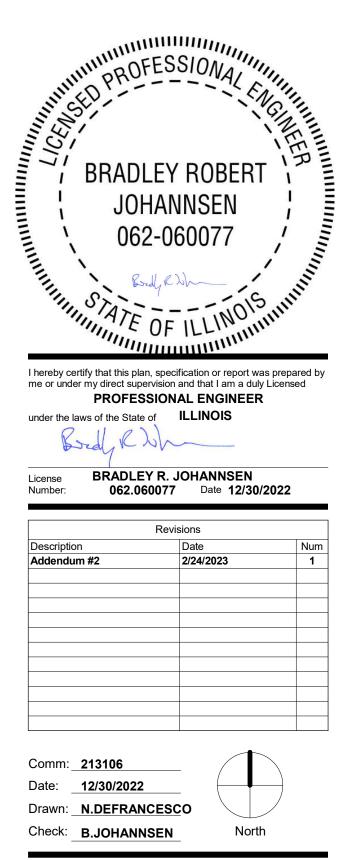
F3 LIGHTNING PROTECTION DETAIL 'TR'

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LIGHTNING PROTECTION



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	LUMINAIRE TYPE	LAMP/ENGINE	VOLT	MOUNTING	LENS/LOUVER	IINAIRE SCHEDULE OTHER REQUIREMENTS	MANUFACTURERS' SERIES NOTES	MARK SPARE	MARK	LUMINAIRE TYPE	LAMP/ENGINE	VOLT	MOUNTING	LENS/LOUVER	MINAIRE SCHEDULE OTHER REQUIREMENTS	MANUFACTURERS' SERIES	NOTES	MARK S
B1	CORRIDOR SCONCE	LED 200 LUMENS 4W		MOUNT CENTER OF BOX AT 5'-6" AFF		ELLIPTICAL CONE SHAPE WITH DIRECT INDIRECT DISTRIBUTION, MACHINED ALUMINUM BODY WITH BLACK FINISH 6"H X 6"W X <4" EXT	EUREKA SLANT 3413 KUZCO SLATE AT68006	B1	AA1	25' PARKING POLE - SINGLE HEAD	LED 9000+ LUMENS 68W		SEE SITE LIGHTING - POLE BASE DETAIL	FORWARD THROW DISTRIBUTION	4000K, BRONZE FINISH, 4" SQUARE STRAIGHT ALUMINUM POLE, 1 HEAD DRILL MOUNTING. INTEGRAL WIRELESS CONTRLS, MOTION SENSOR WITH DIMMING TO 1 FC WHEN UNOCCUPIED.	LITHONIA D-SERIES SIZE 1 SIGNIFY GARDCO PUREFORM LED MEDIUM CURRENT SLING MICRO STRIKE MCGRAW-EDISON GALN GALLEON II	3,4	AA1
B2	TEAMING SCONCE	LED 500 LUMENS DOWN/ 500 LUMENS UP 15W		MOUNT CENTER OF BOX AT 8'-0" AFF	OPEN	4" DIRECT/INDIRECT CYLINDER WALL MOUNT. 20 DEGREE BEAM UP AND DOWN. ALUMINUM BODY WITH MATTE BLACK FINISH. 5-1/2' OUTER DIAM X 19-1/2"H	GOTHAM INCITO ICO4UDWC LIGHTOLIER CALCULITE C3CWUDC	B2	AA2	25' PARKING POLE - 2 HEADS	LED 9000+ LUMENS/ HEAD 136W		SEE SITE LIGHTING - POLE BASE DETAIL	FORWARD THROW DISTRIBUTION	4000K, BRONZE FINISH, 4" SQUARE STRAIGHT ALUMINUM POLE, 2@180 DEGREE DRILL MOUNTING. INTEGRAL WIRELESS CONTROLS, MOTION SENSOR WITH DIMMING TO 1 FC WHEN UNOCCUPIED.	CURRENT SLING MICRO STRIKE	3,4	AA2
C1	4FT UTILITY STRIP	LED 5000 LUMENS 32W		CHAIN HANG AT 3' AFF OR BELOW DUCTWORK	FLAT LENS, FROSTED ACRYLIC	HIGH EFFICIENCY STRIP LIGHT, COMPACT COLD ROLLED STEEL CHANNEL, WHITE FINISH	LITHONIA CLX SERIES HE WILLIAMS 75L SERIES COLUMBIA MPS SERIES METALUX SNLED SERIES DAY-BRITE FSS SERIES	C1	AA3	25' PARKING POLE - SINGLE HEAD	LED 9000+ LUMENS 68W		SEE SITE LIGHTING - POLE BASE DETAIL	FORWARD THROW DISTRIBUTION	4000K, BRONZE FINISH, 4" SQUARE	LITHONIA D-SERIES SIZE 1 SIGNIFY GARDCO PUREFORM LED MEDIUM CURRENT SLING MICRO STRIKE MCGRAW-EDISON GALN GALLEON II	3,4	AA3
C2	8FT UTILITY STRIP CONTINUOUS RUN	LED 8000 LUMENS 64W		CHAIN HANG AT 3' AFF OR BELOW DUCTWORK, PROVIDE WITH ROW ALIGNER.	FLAT LENS, FROSTED ACRYLIC	HIGH EFFICIENCY STRIP LIGHT, COMPACT COLD ROLLED STEEL CHANNEL, WHITE FINISH, WIRING HARNESS	LITHONIA CLX SERIES HE WILLIAMS 75L SERIES COLUMBIA MPS SERIES METALUX SNLED SERIES DAY-BRITE FSS SERIES	C2	AA4	25' PARKING POLE - 3 HEADS	LED 9000+ LUMENS/ HEAD 204W		SEE SITE LIGHTING - POLE BASE DETAIL	FORWARD THROW DISTRIBUTION	4000K, BRONZE FINISH, 4" SQUARE STRAIGHT ALUMINUM POLE, 3@90 DEGREE DRILL MOUNTING. INTEGRAL WIRELSS CONTROLS, MOTION SENSOR WITH DIMMING TO 1 FC WHEN UNOCCUPIED.	LITHONIA D-SERIES SIZE 1 SIGNIFY GARDCO PUREFORM LED MEDIUM CURRENT SLING MICRO STRIKE MCGRAW-EDISON GALN GALLEON II	3,4	AA4
D1	RECESSED LED DOWNLIGHT 4"-500L	LED 500 LUMENS 6W	277V	RECESSED	OPEN	CLEAR TRIM WITH SEMI-SPECULAR FINISH, 0-10V DIMMING DRIVER	LITHONIA LDN4 SERIES LIGHTOLIER CALCULITE 4RN SERIES HE WILLIAMS 4DR SERIES PRESCOLITE LC4LED SERIES PORTFOLIO LD4A SERIES ATLANTIC COM4	D1	AA5	12' PEDESTRIAN POLE - POST TOP	LED 6500+ LUMENS 75W		SEE SITE LIGHTING - POLE BASE DETAIL	TYPE V DISTRIBUTION	4000K COLOR TEMP, BRONZE FINISH, 4" ROUND STRAIGHT ALUMINUM POLE, INTEGRAL MOTION SENSOR WITH DIMMING TO 1 FC WHEN UNOCCUPIED.	LITHONIA RADEAN POST TOP LED SIGNIFY GARDCO PUREFORM LED POST TOP KIM LIGHTING OURO EDGE-LIT POST TOP INVUE LUX LUXESCAPE COLLECTION	3,4	AA5
D2	RECESSED LED DOWNLIGHT 6"-2000L	LED 2000 LUMENS 23W	277V	RECESSED	OPEN		LITHONIA LDN6 SERIES, LIGHTOLIER CALCULITE 6RN SERIES HE WILLIAMS 6DR SERIES PRESCOLITE LC6LED SERIES PORTFOLIO LD6A SERIES ATLANTIC COM6	D2	BB1	BOLLARD	LED 2000+ LUMENS 28W		SEE SITE LIGHTING - POLE BASE DETAIL	SYMMETRIC DISTRIBUTION	4000K COLOR TEMP, BRONZE FINISH 8" ROUND STRAIGHT BOLLARD, 42" HEIGHT		4	BB1
D3	RECESSED LED DOWNLIGHT 6"-1500L SHOWER	LED 1500 LUMENS 14W	277V	RECESSED	IMPACT MODIFIED ACRYIC OR POLYCARBONATE REGRESSED LENS	NON-CONDUCTIVE 'DEAD-FRONT' TRIM, WHITE FLANGE, WET LOCATION RATED, IP65	GOTHAM EVO 6" ROUND SHOWER HE WILLIAMS 6DR SERIES, LIGHTOLIER CALCULITE 6RN SERIES PRESCOLITE LF6SL LENS HALO COMMERCIAL HC6, HM6, 61PS PATHWAY 6SFL2XWL SERIES	D3	DD1	SURFACE LED DOWNLIGHT 13"-1800L	LED 1500+ LUMENS 20W		SURFACE MOUNT IN IC CEILING, PROVIDE WITH IC RATED JUNCTION BOX	DIFFUSE LENS	LOW PROFILE, SURFACE MOUNT DOWNLIGHT, WHITE FINISH, 10"-13" DIAMATER, WET LOCATION.	JUNO JSF DOWNLIGHT HALO SMD12 LED WAC FM-11RN LIGHTOLIER SLIMSURFACE	4	DD1
D4	RECESSED LED DOWNLIGHT 6"-3500L SLOPED, HIGH CEILING	LED 3500 LUMENS 35W	277V	RECESSED	OPEN	CLEAR TRIM WITH SEMI-SPECULAR FINISH, 0-10V DIMMING DRIVER. 20 DEGREE BEAM ANGLE, 15.15 DEGREE CLG ANGLE	GOTHAM 6" INCITO ADJUSTABLE	D4	FF1	FLOOD LIGHT - FLAG	LED 3000+ LUMENS 42W	277V	KNUCKLE WITH 1/2" NPS THREADED PIPE	TEMPERED GLASS LENS	S DIE CAST ALUMINUM, IP66 SEALED HOUSING, POWDERED COAT BRONZE FINISH, MED FLOOD DISTRIBUTION, 4000K COLOR TEMP	LITHONIA D-SERIES FLOOD SIZE 1 SIGNIFY GARDCO DESIGNER FLOOD BEACO VIPOR FLOOD LIGHT MCGRAW-EDISON GFLD GALLEON II FLOODLIGHT		FF1
E1	DIE-CAST ALUMINUM EXIT - SINGLE FACE	LED <5W		JNIVERSAL MOUNT	BRUSHED ALUMINUM FACE WITH MATTE BLACK TRIM, RED LETTERING	DIRECTIONAL CHEVRON KNOCKOUTS, CONCEALED HARDWARE, OVERLAPPING LIGHT SEAL TO PREVENT LIGHT LEAKS, AC ONLY	LITHONIA LQC SERIES CHLORIDE 46 SERIES	E1 4	WW1	EXTERIOR WALL PACK	LED 4000+ LUMENS 39W		MOUNT CENTER OF BOX AT ELEV: 11'-0"	FORWARD THROW	4000K COLOR TEMP, BRONZE FINISH, WET LOCATION RATED, INTEGRAL WIRELESS CONTROLS	LITHONIA WDGE2 LED SERIES SIGNIFY GARDCO PUREFORM BEACON RWL1 RATIO MCGRAW-EDISON GWC GALLEON PERFORMANCE IN LIGHTING SHIELD+2	3,4	WW1
E2	DIE-CAST ALUMINUM EXIT - DOUBLE FACE	LED <5W		JNIVERSAL MOUNT	BRUSHED ALUMINUM FACE WITH MATTE BLACK TRIM, RED LETTERING	DIRECTIONAL CHEVRON KNOCKOUTS, CONCEALED HARDWARE, OVERLAPPING LIGHT SEAL TO PREVENT LIGHT LEAKS, AC ONLY	LITHONIA LQC SERIES CHLORIDE 46 SERIES	E2	GENERAL						NOTES			
EM1	EMERGENCY BATTERY POWERED LIGHTING UNIT	LED 125+ LUMENS 6W		WALL MOUNT ABOVE DOOR	HIGH PERFORMANCE, AIMABLE OPTICS, ACRYLIC LENS	LOW PROFILE, WHITE THERMOPLASTIC HOUSING, NICKEL CADMIUM BATTERY, MIN 90 MINUTES ALLUMINATION UPON LOSS OF POWER, 4000K-5000K COLOR TEMP, SELF-DIAGNOSTICS	LITHONIA ELM2L SERIES, CHLORIDE CLU LIGHT ALARMS LCA-LED2 DUAL-LITE LZ SERIES SURE-LITES LEM SERIES ISOLITE RL2LED SERIES	EM1	B. OBTAI C. PROV	IDE 80+ CRI. SEE PLANS FOR SPECIFIED CO IN LIGHTING CONTROL NETWORK DEVICES I IDE SPARE LUMINAIRES FOR USE DURING C IDE MINIMUM 5 YEAR WARRANTY.	FROM SINGLE SOL	JRCE FRO	M SINGLE MANUFA	CTURER.				
L1	RECESSED LINEAR - 4' LENGTH 3000L	LED 3000 LUMENS 32W	277V	RECESSED ACT	FLUSH, FROSTED, ACRYLIC, CONTINUOUS LENS	6" APERATURE WITH SYMMETRIC DISTRIBUTION, EXTRUDED ALUMINUM CONSRUCTION, 0-10V DIMMING	MARK SLOT 6 LED SERIES, FINITE HP6 AXIS BEAM 6 NEO-RAY DEFINE 6 NULITE REGALO 6 ZUMBOTEL SLOTLIGHT 6 LED	L1	1. VERIF	ED NOTES: Y LENGTH PER PLAN PRIOR TO ORDERING. IDE WITH GENERATOR TRANSFER DEVICE.		~~~~						
L2	RECESSED LINEAR - 4' LENGTH 4000L	LED 4800 LUMENS 40W	277V	RECESSED ACT	FLUSH, FROSTED, ACRYLIC, CONTINUOUS LENS	6" APERATURE WITH SYMMETRIC DISTRIBUTION, EXTRUDED ALUMINUM CONSRUCTION, 0-10V DIMMING	MARK SLOT 6 LED SERIES, FINITE HP6 AXIS BEAM 6 NEO-RAY DEFINE 6 NULITE REGALO 6 ZUMBOTEL SLOTLIGHT 6 LED	L2 ((4. PROVI	ÍÓR TYPËS ŴITH INTEGRAL WIRELESS CON IDE WITH MAX LUMINAIRE UPLIGHT RATING (OF U2.							
L2F - #	RECESSED LINEAR - 4' LENGTH 4000L FLANGE SEE PLANS FOR LENGTH	LED 1200 LUMENS/FT 10W/FT		RECESSED GYP, PROVIDE WITH FLANGE, NSTALL FROM BELOW.	FLUSH, FROSTED, ACRYLIC, CONTINUOUS LENS	DISTRIBUTION, EXTRUDED ALUMINUM CONSRUCTION, 0-10V DIMMING EMERGENCY CIRCUIT -	MARK SLOT 6 LED SERIES, FINITE HP6 1 AXIS BEAM 6 1 NEO-RAY DEFINE 6 1 NULITE REGALO 6 2UMBOTEL SLOTLIGHT 6 LED	L2F - #										
L3 - #	RECESSED LINEAR - 4' LENGTH SEE PLANS FOR LENGTH	LED 600 LUMENS/FT 6W/FT		PERIMETER MOUNT, ACT	FLUSH, FROSTED, ACRYLIC, CONTINUOUS LENS		MARK SLOT 6 LED SERIES, FINITE HP6 1 AXIS BEAM 6 1 NEO-RAY DEFINE 6 1 NULITE REGALO 6 1 ZUMBOTEL SLOTLIGHT 6 LED 1	L3 - #										
L4F	RECESSED LINEAR - 10' LENGTH 3000L	LED 3000 LUMENS 40W			FLUSH, FROSTED,	4" APERATURE WITH SYMMETRIC												
	LINEAR PENDANT MOUNT			FLANGE, NSTALL FROM BELOW.	ACRYLIC, CONTINUOUS LENS		MARK SLOT 4 LED SERIES, FINITE HP6 AXIS BEAM 4 NEO-RAY DEFINE 4 NULITE REGALO 4 ZUMBOTEL SLOTLIGHT 4 LED	L4F										
P1	DIRECT/INDIRECT - 12' LENGTH 640L/FT UP 400L/FT DOWN	LED 12,480 LUMENS 108W	277V	NSTALL FROM BELOW.	LENS FLUSH, FROSTED,	DISTRIBUTION, EXTRUDED ALUMINUM CONSRUCTION, 0-10V DIMMING 6" APERATURE, DIRECT/INDIRECT DISTRIBUTION, EXTRUDED	AXIS BEAM 4 NEO-RAY DEFINE 4 NULITE REGALO 4	L4F P1										
P1 P2	DIRECT/INDIRECT - 12' LENGTH 640L/FT UP	LUMENS	277V 277V 277V	NSTALL FROM BELOW. CABLE MOUNT TO GYP. MOUNT BOTTOM OF FIXTURE AT 10'-0" AFF. SLOPED MOUNT. CABLE MOUNT	LENS FLUSH, FROSTED, ACRYLIC, CONTINUOUS LENS FLUSH, FROSTED,	DISTRIBUTION, EXTRUDED ALUMINUM CONSRUCTION, 0-10V DIMMING 6" APERATURE, DIRECT/INDIRECT DISTRIBUTION, EXTRUDED ALUMINUM CONSRUCTION, 0-10V, WHITE FINISH. 2 CIRCUITS - UP & DOWN LIGHTS SWITCHED SEPARATELY. 5.5" MAX OUTER WIDTH, DIRECT	AXIS BEAM 4 NEO-RAY DEFINE 4 NULITE REGALO 4 ZUMBOTEL SLOTLIGHT 4 LED PAL MICROLINEA SERIES 5 AXIS BEAM 6											
	DIRECT/INDIRECT - 12' LENGTH 640L/FT UP 400L/FT DOWN LINEAR PENDANT MOUNT DIRECT - 24' LENGTH	LUMENS 108W LED 24,000 LUMENS	277V 277V 277V	NSTALL FROM BELOW. CABLE MOUNT TO GYP. MOUNT BOTTOM OF FIXTURE AT 10'-0" AFF. SLOPED MOUNT. CABLE MOUNT TO STRUCTURE. BOTTOM OF FIXTURE FLUSH TO BOTTOM OF	LENS FLUSH, FROSTED, ACRYLIC, CONTINUOUS LENS FLUSH, FROSTED, ACRYLIC, CONTINUOUS LENS FLUSH, FROSTED,	DISTRIBUTION, EXTRUDED ALUMINUM CONSRUCTION, 0-10V DIMMING 6" APERATURE, DIRECT/INDIRECT DISTRIBUTION, EXTRUDED ALUMINUM CONSRUCTION, 0-10V, WHITE FINISH. 2 CIRCUITS - UP & DOWN LIGHTS SWITCHED SEPARATELY. 5.5" MAX OUTER WIDTH, DIRECT DISTRIBUTION, EXTRUDED ALUM CONSRUCTION, 0-10V, BLACK FINISH. EM CIRCUIT - PROVIDE 4' EC SECTIONS PER PLAN. INTEGRAL OCC SENSOR. 5.5" MAX OUTER WIDTH, DIRECT	AXIS BEAM 4 NEO-RAY DEFINE 4 NULITE REGALO 4 ZUMBOTEL SLOTLIGHT 4 LED PAL MICROLINEA SERIES 5 AXIS BEAM 6 OR APPROVED EQUAL PAL MICROLINEA SERIES 5 AXIS BEAM 6 2	P1										
P2 P3	DIRECT/INDIRECT - 12' LENGTH 640L/FT UP 400L/FT DOWN LINEAR PENDANT MOUNT DIRECT - 24' LENGTH 1000L/FT LINEAR PENDANT MOUNT DIRECT - 8' LENGTH 1000L/FT	LUMENS 108W LED 24,000 LUMENS 216W LED 8,000 LUMENS 72W	277V 277V 277V 277V	NSTALL FROM BELOW. CABLE MOUNT TO GYP. MOUNT BOTTOM OF FIXTURE AT 10'-0" AFF. SLOPED MOUNT. CABLE MOUNT TO STRUCTURE. BOTTOM OF FIXTURE FLUSH TO STRUCTURE. BOTTOM OF FIXTURE FLUSH TO BOTTOM OF	LENS FLUSH, FROSTED, ACRYLIC, CONTINUOUS LENS FLUSH, FROSTED, ACRYLIC, CONTINUOUS LENS FLUSH, FROSTED, ACRYLIC, CONTINUOUS LENS FLUSH, FROSTED,	 DISTRIBUTION, EXTRUDED ALUMINUM CONSRUCTION, 0-10V DIMMING 6" APERATURE, DIRECT/INDIRECT DISTRIBUTION, EXTRUDED ALUMINUM CONSRUCTION, 0-10V, WHITE FINISH. 2 CIRCUITS - UP & DOWN LIGHTS SWITCHED SEPARATELY. 5.5" MAX OUTER WIDTH, DIRECT DISTRIBUTION, EXTRUDED ALUM CONSRUCTION, 0-10V, BLACK FINISH. EM CIRCUIT - PROVIDE 4' EC SECTIONS PER PLAN. INTEGRAL OCC SENSOR. 5.5" MAX OUTER WIDTH, DIRECT DISTRIBUTION, EXTRUDED ALUM CONSRUCTION, 0-10V, BLACK FINISH. EM CIRCUIT - PROVIDE 4' EC SECTIONS PER PLAN. INTEGRAL OCC SENSOR. 5.5" MAX OUTER WIDTH, DIRECT DISTRIBUTION, EXTRUDED ALUM CONSRUCTION, 0-10V, BLACK FINISH. EM CIRCUIT - PROVIDE 4' EC SECTIONS PER PLAN. INTEGRAL OCC & DAYLIGHT SENSOR. 6" APERATURE, DIRECT/INDIRECT 	AXIS BEAM 4 NEO-RAY DEFINE 4 NULITE REGALO 4 ZUMBOTEL SLOTLIGHT 4 LED PAL MICROLINEA SERIES 5 AXIS BEAM 6 OR APPROVED EQUAL PAL MICROLINEA SERIES 5 AXIS BEAM 6 OR APPROVED EQUAL PAL MICROLINEA SERIES 5 AXIS BEAM 6 OR APPROVED EQUAL 2	P1										
P2 P3	DIRECT/INDIRECT - 12' LENGTH 640L/FT UP 400L/FT DOWN LINEAR PENDANT MOUNT DIRECT - 24' LENGTH 1000L/FT LINEAR PENDANT MOUNT DIRECT - 8' LENGTH 1000L/FT LINEAR PENDANT MOUNT DIRECT - SEE PLANS FOR LENGTH 640L/FT UP	LUMENS 108W LED 24,000 LUMENS 216W LED 8,000 LUMENS 72W	277V 277V 277V 277V 277V 277V	NSTALL FROM BELOW. CABLE MOUNT TO GYP. MOUNT BOTTOM OF FIXTURE AT 10'-0" AFF. SLOPED MOUNT. CABLE MOUNT TO STRUCTURE. BOTTOM OF FIXTURE FLUSH TO BOTTOM OF FIXTURE FLUSH TO STRUCTURE. BOTTOM OF FIXTURE FLUSH TO BOTTOM OF FIXTURE FLUSH TO BOTTOM OF FIXTURE FLUSH TO GYP. MOUNT BOTTOM OF FIXTURE AT 10'-0" AFF.	LENS FLUSH, FROSTED, ACRYLIC, CONTINUOUS LENS FLUSH, FROSTED, ACRYLIC, CONTINUOUS LENS FLUSH, FROSTED, ACRYLIC, CONTINUOUS LENS FLUSH, FROSTED, ACRYLIC, CONTINUOUS LENS FLUSH, FROSTED, ACRYLIC, CONTINUOUS LENS	 DISTRIBUTION, EXTRUDED ALUMINUM CONSRUCTION, 0-10V DIMMING 6" APERATURE, DIRECT/INDIRECT DISTRIBUTION, EXTRUDED ALUMINUM CONSRUCTION, 0-10V, WHITE FINISH. 2 CIRCUITS - UP & DOWN LIGHTS SWITCHED SEPARATELY. 5.5" MAX OUTER WIDTH, DIRECT DISTRIBUTION, EXTRUDED ALUM CONSRUCTION, 0-10V, BLACK FINISH. EM CIRCUIT - PROVIDE 4' EC SECTIONS PER PLAN. INTEGRAL OCC SENSOR. 5.5" MAX OUTER WIDTH, DIRECT DISTRIBUTION, EXTRUDED ALUM CONSRUCTION, 0-10V, BLACK FINISH. EM CIRCUIT - PROVIDE 4' EC SECTIONS PER PLAN. INTEGRAL OCC SENSOR. 6" APERATURE, DIRECT/INDIRECT DISTRIBUTION, EXTRUDED ALUM CONSRUCTION, 0-10V, WHITE FINISH. 2 CIRCUITS - UP & DOWN. EC SECTION PER PLANS. INTEGRAL OCC SENSOR PER PLANS 6" APERATURE, DIRECT/INDIRECT 	AXIS BEAM 4 NEO-RAY DEFINE 4 NULITE REGALO 4 ZUMBOTEL SLOTLIGHT 4 LED	P1 P2 P3										
P2 P3 P4 - #	DIRECT/INDIRECT - 12' LENGTH 640L/FT UP 400L/FT DOWN LINEAR PENDANT MOUNT DIRECT - 24' LENGTH 1000L/FT LINEAR PENDANT MOUNT DIRECT - 8' LENGTH 1000L/FT LINEAR PENDANT MOUNT DIRECT - SEE PLANS FOR LENGTH 640L/FT UP 400L/FT DOWN LINEAR PENDANT MOUNT DIRECT/INDIRECT - 88' TOTAL LENGTH 640L/FT DOWN	LUMENS 108W LED 24,000 LUMENS 216W LED 8,000 LUMENS 72W E LED 1,040 LUMENS/FT 9W/FT	277V 277V 277V 277V 277V 277V 277V	NSTALL FROM BELOW. CABLE MOUNT TO GYP. MOUNT BOTTOM OF FIXTURE AT 10'-0" AFF. SLOPED MOUNT. CABLE MOUNT TO STRUCTURE. BOTTOM OF FIXTURE FLUSH TO BOTTOM OF FIXTURE AT 10'-0" AFF. SLOPED MOUNT. CABLE MOUNT TO GYP. MOUNT BOTTOM OF FIXTURE AT 10'-0" AFF. SLOPED MOUNT. CABLE MOUNT TO GYP. MOUNT SOTTOM OF FIXTURE AT 10'-0" AFF.	LENS FLUSH, FROSTED, ACRYLIC, CONTINUOUS LENS FLUSH, FROSTED, ACRYLIC, CONTINUOUS LENS FLUSH, FROSTED, ACRYLIC, CONTINUOUS LENS FLUSH, FROSTED, ACRYLIC, CONTINUOUS LENS FLUSH, FROSTED, ACRYLIC, CONTINUOUS LENS CYLINDER SNOOT	 DISTRIBUTION, EXTRUDED ALUMINUM CONSRUCTION, 0-10V DIMMING 6" APERATURE, DIRECT/INDIRECT DISTRIBUTION, EXTRUDED ALUMINUM CONSRUCTION, 0-10V, WHITE FINISH. 2 CIRCUITS - UP & DOWN LIGHTS SWITCHED SEPARATELY. 5.5" MAX OUTER WIDTH, DIRECT DISTRIBUTION, EXTRUDED ALUM CONSRUCTION, 0-10V, BLACK FINISH. EM CIRCUIT - PROVIDE 4' EC SECTIONS PER PLAN. INTEGRAL OCC SENSOR. 5.5" MAX OUTER WIDTH, DIRECT DISTRIBUTION, EXTRUDED ALUM CONSRUCTION, 0-10V, BLACK FINISH. EM CIRCUIT - PROVIDE 4' EC SECTIONS PER PLAN. INTEGRAL OCC & DAYLIGHT SENSOR. 6" APERATURE, DIRECT/INDIRECT DISTRIBUTION, EXTRUDED ALUM CONSRUCTION, 0-10V, WHITE FINISH. 2 CIRCUITS - UP & DOWN. EC SECTION PER PLANS. INTEGRAL OCC SENSOR PER PLANS 6" APERATURE, DIRECT/INDIRECT DISTRIBUTION, EXTRUDED ALUM CONSRUCTION, 0-10V, WHITE FINISH. 2 CIRCUITS - UP & DOWN. EC SECTION PER PLANS. INTEGRAL OCC SENSOR PER PLANS 6" APERATURE, DIRECT/INDIRECT DISTRIBUTION, EXTRUDED ALUM CONSRUCTION, 0-10V, WHITE FINISH. 2 CIRCUITS - UP & DOWN. EC SECTION PER PLANS. INTEGRAL OCC SENSOR PER PLANS 6" APERATURE, DIRECT/INDIRECT DISTRIBUTION, EXTRUDED ALUM CONSRUCTION, 0-10V, WHITE FINISH. 2 CIRCUITS - UP & DOWN. EC SECTION PER PLANS. INTEGRAL OCC & DAYLGT SENSOR PER PLANS 	AXIS BEAM 4 NEO-RAY DEFINE 4 NULITE REGALO 4 ZUMBOTEL SLOTLIGHT 4 LEDImage: Comparison of the second seco	P1 P2 P3 P3 P4 - #										
P2 P3 P4 - #	DIRECT/INDIRECT - 12' LENGTH 640L/FT UP 400L/FT DOWN LINEAR PENDANT MOUNT DIRECT - 24' LENGTH 1000L/FT LINEAR PENDANT MOUNT DIRECT - 8' LENGTH 1000L/FT LINEAR PENDANT MOUNT DIRECT - SEE PLANS FOR LENGTH 640L/FT UP 400L/FT DOWN LINEAR PENDANT MOUNT DIRECT/INDIRECT - 88' TOTAL LENGTH 640L/FT DOWN 400L/FT DOWN	LUMENS 108W LED 24,000 LUMENS 216W LED 8,000 LUMENS 72W LED 1,040 LUMENS/FT 9W/FT LED 1,040 LUMENS/FT 9W/FT LED 1,040 LUMENS/FT 9W/FT	277V 277V 277V 277V 277V 277V 277V 277V	NSTALL FROM BELOW. CABLE MOUNT TO GYP. MOUNT BOTTOM OF FIXTURE AT 10'-0" AFF. SLOPED MOUNT. CABLE MOUNT TO STRUCTURE. BOTTOM OF FIXTURE FLUSH TO BOTTOM OF FIXTURE FLUSH TO BOTTOM OF FIXTURE FLUSH TO STRUCTURE. BOTTOM OF FIXTURE FLUSH TO BOTTOM OF FIXTURE FLUSH TO BOTTOM OF FIXTURE FLUSH TO BOTTOM OF FIXTURE AT 10'-0" AFF. SLOPED MOUNT BOTTOM OF FIXTURE AT 10'-0" AFF. SLOPED MOUNT	LENS FLUSH, FROSTED, ACRYLIC, CONTINUOUS LENS FLUSH, FROSTED, ACRYLIC, CONTINUOUS LENS FLUSH, FROSTED, ACRYLIC, CONTINUOUS LENS FLUSH, FROSTED, ACRYLIC, CONTINUOUS LENS FLUSH, FROSTED, ACRYLIC, CONTINUOUS LENS CYLINDER SNOOT DOWNLIGHT, 30 DEGREE	 DISTRIBUTION, EXTRUDED ALUMINUM CONSRUCTION, 0-10V DIMMING 6" APERATURE, DIRECT/INDIRECT DISTRIBUTION, EXTRUDED ALUMINUM CONSRUCTION, 0-10V, WHITE FINISH. 2 CIRCUITS - UP & DOWN LIGHTS SWITCHED SEPARATELY. 5.5" MAX OUTER WIDTH, DIRECT DISTRIBUTION, EXTRUDED ALUM CONSRUCTION, 0-10V, BLACK FINISH. EM CIRCUIT - PROVIDE 4' EC SECTIONS PER PLAN. INTEGRAL OCC SENSOR. 5.5" MAX OUTER WIDTH, DIRECT DISTRIBUTION, EXTRUDED ALUM CONSRUCTION, 0-10V, BLACK FINISH. EM CIRCUIT - PROVIDE 4' EC SECTIONS PER PLAN. INTEGRAL OCC & DAYLIGHT SENSOR. 6" APERATURE, DIRECT/INDIRECT DISTRIBUTION, EXTRUDED ALUM CONSRUCTION, 0-10V, WHITE FINISH. 2 CIRCUITS - UP & DOWN. EC SECTION PER PLANS. INTEGRAL OCC SENSOR PER PLANS. 6" APERATURE, DIRECT/INDIRECT DISTRIBUTION, EXTRUDED ALUM CONSRUCTION, 0-10V, WHITE FINISH. 2 CIRCUITS - UP & DOWN. EC SECTION PER PLANS. INTEGRAL OCC SENSOR PER PLANS 6" APERATURE, DIRECT/INDIRECT DISTRIBUTION, EXTRUDED ALUM CONSRUCTION, 0-10V, WHITE FINISH. 2 CIRCUITS - UP & DOWN. EC SECTION PER PLANS. INTEGRAL OCC SENSOR PER PLANS 6" APERATURE, DIRECT/INDIRECT DISTRIBUTION, EXTRUDED ALUM CONSRUCTION, 0-10V, WHITE FINISH. 2 CIRCUITS - UP & DOWN. EC SECTION PER PLANS. INTEGRAL OCC & DAYLGT SENSOR PER PLANS TWIN CABLE POWERED SUSPENDED CATENARY SYSTEM W/MATTE BLACK ALUMINUM CYLINDERS, 0-10V DIMMING, REMOTE DRIVER, PROVIDE WITH ALL REQUIRED MOUNTING HARDWARE. STREAMLINED NARROW BODY, 	AXIS BEAM 4 NEO-RAY DEFINE 4 NULITE REGALO 4 ZUMBOTEL SLOTLIGHT 4 LEDImage: Comparison of the series seri	P1 P2 P3 P3 P4 - # P5										
P2 P3 P4 - # P5 P6	DIRECT/INDIRECT - 12' LENGTH 640L/FT UP 400L/FT DOWN LINEAR PENDANT MOUNT DIRECT - 24' LENGTH 1000L/FT LINEAR PENDANT MOUNT DIRECT - 8' LENGTH 1000L/FT LINEAR PENDANT MOUNT DIRECT - SEE PLANS FOR LENGTH 640L/FT UP 400L/FT DOWN LINEAR PENDANT MOUNT DIRECT/INDIRECT - 88' TOTAL LENGTH 640L/FT DOWN 400L/FT DOWN 400L/FT DOWN	LUMENS 108W108WLED 24,000 LUMENS 216WLED 8,000 LUMENS 72WLED 1,040 LUMENS/FT 9W/FTLED 1,040 LUMENS/FT 9W/FTLED 1,040 LUMENS/FT 9W/FTLED 1,040 LUMENS/FT 9W/FTLED 780 LUMENS/ CYLINDER 10W/ CYLINDER LUMENSLED 900+ LUMENS	277V 277V 277V 277V 277V 277V 277V 277V 120V 120V	NSTALL FROM BELOW. CABLE MOUNT TO GYP. MOUNT TO GYP. MOUNT BOTTOM OF FIXTURE AT 10'-0" AFF. SLOPED MOUNT. CABLE MOUNT TO STRUCTURE. BOTTOM OF FIXTURE FLUSH TO BOTTOM OF FIXTURE AT 10'-0" AFF. SLOPED MOUNT BOTTOM OF FIXTURE AT 10'-0" AFF. SLOPED MOUNT TO GYP. MOUNT SOTTOM OF FIXTURE AT 10'-0" AFF. SLOPED MOUNT SOTTOM OF FIXTURE AT 10'-0" AFF. SLOPED MOUNT MOUNT AT 12'-6" AFF. SEE PLANS FOR DIMENSIONED MOUNT TO SOTTOM OF	LENS FLUSH, FROSTED, ACRYLIC, CONTINUOUS LENS FLUSH, FROSTED, ACRYLIC, CONTINUOUS LENS	DISTRIBUTION, EXTRUDED ALUMINUM CONSRUCTION, 0-10V DIMMING 6" APERATURE, DIRECT/INDIRECT DISTRIBUTION, EXTRUDED ALUMINUM CONSRUCTION, 0-10V, WHITE FINISH. 2 CIRCUITS - UP & DOWN LIGHTS SWITCHED SEPARATELY. 5.5" MAX OUTER WIDTH, DIRECT DISTRIBUTION, EXTRUDED ALUM CONSRUCTION, 0-10V, BLACK FINISH. EM CIRCUIT - PROVIDE 4' EC SECTIONS PER PLAN. INTEGRAL OCC SENSOR. 5.5" MAX OUTER WIDTH, DIRECT DISTRIBUTION, EXTRUDED ALUM CONSRUCTION, 0-10V, BLACK FINISH. EM CIRCUIT - PROVIDE 4' EC SECTIONS PER PLAN. INTEGRAL OCC SENSOR. 6" APERATURE, DIRECT/INDIRECT DISTRIBUTION, EXTRUDED ALUM CONSRUCTION, 0-10V, WHITE FINISH. 2 CIRCUITS - UP & DOWN. EC SECTION PER PLANS. INTEGRAL OCC SENSOR PER PLANS 6" APERATURE, DIRECT/INDIRECT DISTRIBUTION, EXTRUDED ALUM CONSRUCTION, 0-10V, WHITE FINISH. 2 CIRCUITS - UP & DOWN. EC SECTION PER PLANS. INTEGRAL OCC SENSOR PER PLANS 10STRIBUTION, EXTRUDED ALUM	AXIS BEAM 4 NEO-RAY DEFINE 4 NULITE REGALO 4 ZUMBOTEL SLOTLIGHT 4 LEDPAL MICROLINEA SERIES 5 AXIS BEAM 6 OR APPROVED EQUAL2PAL MICROLINEA SERIES 5 AXIS BEAM 6 OR APPROVED EQUAL1.2PAL MICROLINEA SERIES	P1 P2 P2 P3 P4 - # P5 P6										
P2 P3 P4 - # P5 P6 U1 U2	DIRECT/INDIRECT - 12' LENGTH 640L/FT UP 400L/FT DOWN LINEAR PENDANT MOUNT DIRECT - 24' LENGTH 1000L/FT LINEAR PENDANT MOUNT DIRECT - 8' LENGTH 1000L/FT LINEAR PENDANT MOUNT DIRECT - SEE PLANS FOR LENGTH 640L/FT UP 400L/FT DOWN LINEAR PENDANT MOUNT DIRECT/INDIRECT - 88' TOTAL LENGTH 640L/FT DOWN 400L/FT DOWN 400L/FT DOWN LINEAR PENDANT MOUNT DIRECT/INDIRECT - 88' TOTAL LENGTH 640L/FT DOWN 400L/FT DOWN LINEAR PENDANT MOUNT DIRECT/INDIRECT - 18"	LUMENS 108W108WLED 24,000 LUMENS 216WLED 8,000 LUMENS 72WLED 1,040 LUMENS/FT 9W/FTLED 1,040 LUMENS/FT 9W/FTLED 1,040 LUMENS/FT 9W/FTLED 1,040 LUMENS/FT 9W/FTLED 780 LUMENS/ CYLINDER 10W/ CYLINDER 10WLED 900+ LUMENS 10WLED 1800+ LUMENSLED 1800+ LUMENS	277V 277V 277V 277V 277V 277V 277V 277V 120V 120V	NSTALL FROM BELOW. CABLE MOUNT TO GYP. MOUNT BOTTOM OF FIXTURE AT 10'-0" AFF. SLOPED MOUNT. CABLE MOUNT TO STRUCTURE. BOTTOM OF FIXTURE FLUSH TO BOTTOM OF FIXTURE AT 10'-0" AFF. SLOPED MOUNT. CABLE MOUNT BOTTOM OF FIXTURE AT 10'-0" AFF. SLOPED MOUNT BOTTOM OF FIXTURE AT 10'-0" AFF. SLOPED MOUNT SOTTOM OF FIXTURE AT 10'-0" AFF. SLOPED MOUNT SOTTOM OF FIXTURE AT 10'-0" AFF. SLOPED MOUNT MOUNT AT 12'-6" AFF. SEE PLANS FOR DIMENSIONED MOUNT TO BOTTOM OF CABINET	LENSFLUSH, FROSTED, ACRYLIC, CONTINUOUS LENSFLUSH, FROSTED, ACRYLIC, CONTINUOUS LENSHIGH IMPACT ACRYLIC OR POLYCARBONATE LENSHIGH IMPACT ACRYLIC OR POLYCARBONATEHIGH IMPACT ACRYLIC OR POLYCARBONATE	DISTRIBUTION, EXTRUDED ALUMINUM CONSRUCTION, 0-10V DIMMING 6" APERATURE, DIRECT/INDIRECT DISTRIBUTION, EXTRUDED ALUMINUM CONSRUCTION, 0-10V, WHITE FINISH. 2 CIRCUITS - UP & DOWN LIGHTS SWITCHED SEPARATELY. 5.5" MAX OUTER WIDTH, DIRECT DISTRIBUTION, EXTRUDED ALUM CONSRUCTION, 0-10V, BLACK FINISH. EM CIRCUIT - PROVIDE 4' EC SECTIONS PER PLAN. INTEGRAL OCC SENSOR. 5.5" MAX OUTER WIDTH, DIRECT DISTRIBUTION, EXTRUDED ALUM CONSRUCTION, 0-10V, BLACK FINISH. EM CIRCUIT - PROVIDE 4' EC SECTIONS PER PLAN. INTEGRAL OCC & DAYLIGHT SENSOR. 6" APERATURE, DIRECT/INDIRECT DISTRIBUTION, EXTRUDED ALUM CONSRUCTION, 0-10V, WHITE FINISH. 2 CIRCUITS - UP & DOWN. EC SECTION PER PLANS. INTEGRAL OCC SENSOR PER PLANS 6" APERATURE, DIRECT/INDIRECT DISTRIBUTION, EXTRUDED ALUM CONSRUCTION, 0-10V, WHITE FINISH. 2 CIRCUITS - UP & DOWN. EC SECTION PER PLANS. INTEGRAL OCC SENSOR PER PLANS 6" APERATURE, DIRECT/INDIRECT DISTRIBUTION, EXTRUDED ALUM CONSRUCTION, 0-10V, WHITE FINISH. 2 CIRCUITS - UP & DOWN. EC SECTION PER PLANS. INTEGRAL OCC & DAYLGT SENSOR PER PLANS 7 WIN CABLE POWERED SUSPENDED CATENARY SYSTEM W/MATTE BLACK ALUMINUM CYLINDERS, 0-10V DIMMING, REMOTE DRIVER, PROVIDE WITH ALL REQUIRED MOUNTING HARDWARE. 5 TREAMLINED NARROW BODY, SOLID FRONT HOUSING, 16"-20" LENGTH, IN HARDWIRE BOX, WHITE FINISH	AXIS BEAM 4 NEO-RAY DEFINE 4 NULITE REGALO 4 ZUMBOTEL SLOTLIGHT 4 LEDPAL MICROLINEA SERIES 5 AXIS BEAM 6 OR APPROVED EQUALPAL MICROLINEA SERIES HEALTHCARE LIGHTING SPECTRA-SF LED KENALL STRATALUME MAUCLED NEW STAR STARMED MUS UNDERCABINET LED FAIL-SAFE UCL DAY-BRITE LINCS SERIESPAY-BRITE LINCS SERIESSPILIGHTING ECHO PERFORMANCE COVE 6.0	P1 P2 P2 P3 P4 - # P5 P6 U1										

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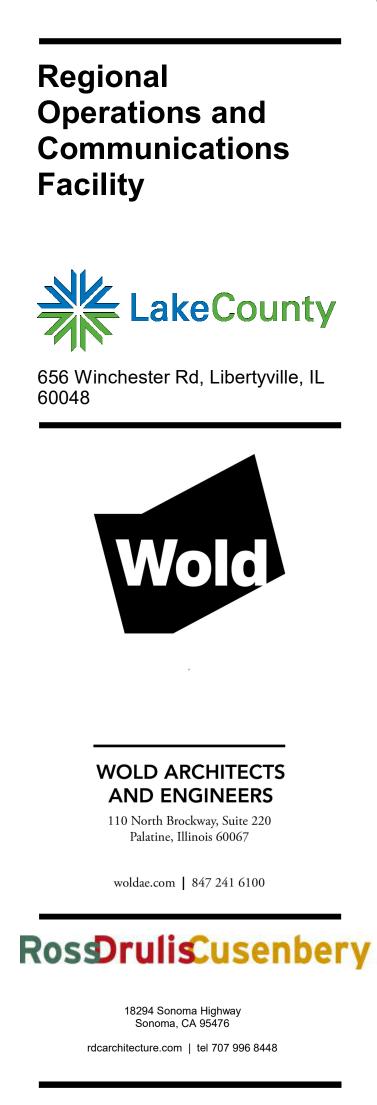
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I hereby certify that this plan, specification or report was prepared by me or under my direct supervision and that I am a duly Licensed PROFESSIONAL ENGINEER under the laws of the State of ILLINOIS

_____ License BRADLEY R. JOHANNSEN Number: 062.060077 Date 12/30/2022

Revisions						
Description	Date	Num				
Addendum #2	2/24/2023	1				

Comm: 213106 Date: 12/30/2022 Drawn: <u>H. Nelson</u> Check: B. Johannsen

LUMINAIRE SCHEDULE

Scale: **1/8" = 1'-0"**

E6.01

		MOTOR SCHEDULE																				
	OAD INFORMATION			CONDUIT		WIRE QUANT	ITY AND SIZE		WIRE TYPE									CTRL'S	NOTES	MTR	NOTES	
MTR	DESCRIPTION	LOC	LOAD UNIT VOLTAGE	E PANEL	SET(S) SIZE	TYPE P+	N PHASE	NEUT	GND	TYPE INSU	L SUPPLIED	INSTALLED	SIZE	LOC	SUPPLIED	INSTALLED	TYPE	TYPE	LOC	BY		
GHP-1	GEOTHERMAL HEAT PUMP	MECHANICAL & FIRE SPRINKLER ROOM	199 MCA 480/3	DP-CH11	1 2"	EMT 3	3/0 AWG		6 AWG	CU THH		MFR		MTR	ELEC	ELEC	FS	200A	MTR	MECH		GHP-1
B-1	BOILER	MECHANICAL & FIRE SPRINKLER ROOM	255 FLA 480/3	DP-CH11	1 2 1/2"	EMT 3	250 KCMIL		4 AWG	CU THH	N MFR	MFR		MTR	ELEC	ELEC	FS	400A	MTR	MECH		B-1
AHU-1: SF-1	AIR HANDLING UNIT SUPPLY	MECHANICAL & FIRE SPRINKLER ROOM	7.5 HP 480/3	DP-CH11	1 3/4"	EMT 3	12 AWG		12 AWG	CU THH	N MECH	ELEC		MTR	ELEC	ELEC	NFS	30A	MTR	MECH	FEED VIA VFD SUPPLIED BY OTHERS	AHU-1: SF-1
AHU-1: SF-1		MECHANICAL & FIRE SPRINKLER ROOM	7.5 HP 480/3	-	1 3/4		12 AWG		12 AWG 12 AWG			ELEC		MTR	ELEC	ELEC	NFS NFS	30A	MTR	MECH	FEED VIA VFD SOPPLIED BY OTHERS	AHU-1: SF-1
AHU-1: RF-1	AIR HANDLING UNIT RETURN	MECHANICAL & FIRE SPRINKLER ROOM	3 HP 480/3	DP-CH11	1 3/4"		12 AWG		12 AWG	CU THH		ELEC		MTR	ELEC	ELEC	NFS	30A	MTR	MECH	FEED VIA VFD SUPPLIED BY OTHERS; PROVIDE DUCT SMOKE DETECTOR IN RETURN	AHU-1: RF-1
AHU-1: RF-2	AIR HANDLING UNIT RETURN	MECHANICAL & FIRE SPRINKLER ROOM	3 HP 480/3	DP-CH11	1 3/4"	EMT 3	12 AWG		12 AWG	CU THH		ELEC		MTR	ELEC	ELEC	NFS	30A	MTR	MECH	FEED VIA VFD SUPPLIED BY OTHERS	AHU-1: RF-2
AHU-1: UV	AHU - UV LIGHTS	AHU-1	.5 KVA 120/1	CL10	1 3/4"	EMT 2	12 AWG	12 AWG	12 AWG	CU THH	N				ELEC	ELEC	MMS	15A	MTR	MECH		AHU-1: UV
AHU-1: AUX	AHU - LIGHTS & RECEP	AHU-1	.1 KVA 120/1	CL10	1 3/4"	EMT 2	12 AWG	12 AWG	12 AWG	CU THH	N				ELEC	ELEC	MMS	15A	MTR	MECH		AHU-1: AUX
	AIR HANDLING UNIT SUPPLY	MECHANICAL & FIRE SPRINKLER ROOM	10 HP 480/3	DP-CH11	1 3/4"	EMT 3	12 0100		12 AWG	CU THH	N MECH	ELEC		MTR	ELEC	ELEC	NEC	30A	MTR	MECH	FEED VIA VFD SUPPLIED BY OTHERS	AHU-2: SF-1
AHU-2: SF-1 AHU-2: SF-2	AIR HANDLING UNIT SUPPLY	MECHANICAL & FIRE SPRINKLER ROOM	10 HP 480/3	DP-CH11 DP-CH11	1 3/4		12 AWG 12 AWG		12 AWG	CU THH	-	ELEC		MTR	ELEC	ELEC	NFS NFS	30A 30A	MIR	MECH	FEED VIA VFD SUPPLIED BY OTHERS	AHU-2: SF-1 AHU-2: SF-2
AHU-2: RF-1	AIR HANDLING UNIT RETURN	MECHANICAL & FIRE SPRINKLER ROOM	5 HP 480/3	DP-CH11	1 3/4"		12 AWG		12 AWG	CU THH		ELEC		MTR	ELEC	ELEC	NFS	30A	MTR	MECH	FEED VIA VFD SUPPLIED BY OTHERS; PROVIDE DUCT SMOKE DETECTOR IN RETURN	AHU-2: RF-1
AHU-2: RF-2	AIR HANDLING UNIT RETURN	MECHANICAL & FIRE SPRINKLER ROOM	5 HP 480/3	DP-CH11	1 3/4"	EMT 3	12 AWG		12 AWG	CU THH	N MECH	ELEC		MTR	ELEC	ELEC	NFS	30A	MTR	MECH	FEED VIA VFD SUPPLIED BY OTHERS	AHU-2: RF-2
AHU-2: UV	AHU - UV LIGHTS	AHU-2	.5 KVA 120/1	CL10	1 3/4"	EMT 2	12 AWG	12 AWG	12 AWG	CU THH					ELEC	ELEC	MMS	15A	MTR	MECH		AHU-2: UV
AHU-2: AUX	AHU - LIGHTS & RECEP	AHU-2	.1 KVA 120/1	CL10	1 3/4"		12 AWG	12 AWG	12 AWG	CU THH					ELEC	ELEC	MMS	15A	MTR	MECH		AHU-2: AUX
AHU-2 RW	AIR HANDLING UNIT RECOVERY WHEEL	MECHANICAL & FIRE SPRINKLER ROOM	1.1 FLA 480/3	DP-CH11	1 3/4"	EMT 3	12 AWG		12 AWG	CU THH	N MECH	ELEC		MTR	ELEC	ELEC	NFS	30A	MTR	MECH	FEED VIA VFD SUPPLIED BY OTHERS; PROVIDE DUCT SMOKE DETECTOR IN RETURN	AHU-2 RW
AHU-3: SF-1	AIR HANDLING UNIT SUPPLY	MEZZANINE	7.5 HP 480/3	PH-20	1 3/4"	EMT 3	12 AWG		12 AWG	CU THH	N MECH	ELEC		MTR	ELEC	ELEC	NFS	30A	MTR	MECH	FEED VIA VFD SUPPLIED BY OTHERS	AHU-3: SF-1
AHU-3: SF-2	AIR HANDLING UNIT SUPPLY	MEZZANINE	7.5 HP 480/3	PH-20	1 3/4"		12 AWG		12 AWG	CU THH		ELEC		MTR	ELEC	ELEC	NFS	30A	MTR	MECH	FEED VIA VI D SOIT FEED DI OTHERS	AHU-3: SF-2
AHU-3: RF-1	AIR HANDLING UNIT RETURN	MEZZANINE	4.8 FLA 480/3	PH-20	1 3/4"	EMT 3	12 AWG		12 AWG	CU THH	N MECH	ELEC		MTR	ELEC	ELEC	NFS	30A	MTR	MECH	FEED VIA VFD SUPPLIED BY OTHERS; PROVIDE DUCT SMOKE DETECTOR IN RETURN	AHU-3: RF-1
AHU-3: RF-2	AIR HANDLING UNIT RETURN	MEZZANINE	4.8 FLA 480/3	PH-20	1 3/4"		12 AWG		12 AWG	CU THH		ELEC		MTR	ELEC	ELEC	NFS	30A	MTR	MECH	FEED VIA VFD SUPPLIED BY OTHERS	AHU-3: RF-2
AHU-3: UV	AHU - UV LIGHTS	AHU-3	.5 KVA 120/1	PL20	1 3/4"	EMT 2	12 AWG	12 AWG	12 AWG	CU THH					ELEC	ELEC	MMS	15A	MTR	MECH		AHU-3: UV
AHU-3: AUX	AHU - LIGHTS & RECEP	AHU-3	.1 KVA 120/1	PL20	1 3/4"	EMT 2	12 AWG	12 AWG	12 AWG	CU THH	N				ELEC	ELEC	MMS	15A	MTR	MECH		AHU-3: AUX
P-1	PUMP	MECHANICAL & FIRE SPRINKLER ROOM	10 HP 480/3	DP-CH11	1 3/4"	EMT 3	12 AWG		12 AWG	CU THH	N MECH			MTR	ELEC	ELEC	NFS	30A	MTR	MECH	FEED VIA VFD SUPPLIED BY OTHERS	P-1
P-1	PUMP	MECHANICAL & FIRE SPRINKLER ROOM	10 HP 480/3	DP-CH11	1 3/4		12 AWG		12 AWG					MTR	ELEC	ELEC	NFS	30A	MTR	MECH	FEED VIA VFD SOFFLIED BY OTHERS	P-1
P-3	PUMP	MECHANICAL & FIRE SPRINKLER ROOM	5 HP 480/3	DP-CH11	1 3/4"		12 AWG		12 AWG	CU THH				MTR	ELEC	ELEC	NFS	30A	MTR	MECH	FEED VIA VFD SUPPLIED BY OTHERS	P-3
P-4	PUMP	MECHANICAL & FIRE SPRINKLER ROOM	5 HP 480/3	DP-CH11	1 3/4"	EMT 3	12 AWG		12 AWG	CU THH	N MECH			MTR	ELEC	ELEC	NFS	30A	MTR	MECH	FEED VIA VFD SUPPLIED BY OTHERS	P-4
P-5	PUMP	MECHANICAL & FIRE SPRINKLER ROOM	5 HP 480/3	DP-CH11	1 3/4"	EMT 3	12 AWG		12 AWG	CU THH				MTR	ELEC	ELEC	NFS	30A	MTR	MECH	FEED VIA VFD SUPPLIED BY OTHERS	P-5
P-6	PUMP	MECHANICAL & FIRE SPRINKLER ROOM	5 HP 480/3		1 3/4"		12 AWG		12 AWG	CU THH				MTR	ELEC	ELEC	NFS	30A	MTR	MECH	FEED VIA VFD SUPPLIED BY OTHERS	P-6
P-7 P-8	PUMP PUMP	MECHANICAL & FIRE SPRINKLER ROOM	1 HP 480/3		1 3/4" 1 3/4"		12 AWG	12 0/0/0	12 AWG					MTR	ELEC	ELEC	NFS MMS	30A 15A	MTR MTR	MECH MECH	FEED VIA VED SUPPLIED BY OTHERS	P-7 P-8
P-8	PUMP	MECHANICAL & FIRE SPRINKLER ROOM	4.4 FLA 120/1	CL10	1 3/4	EMI 2	12 AWG	12 AWG	12 AWG	CU THH					ELEC	ELEC	MM5	15A	MIR	MECH	FEED VIA VFD SUPPLIED BY OTHERS	P-8
FP-1	FIRE PUMP	MECHANICAL & FIRE SPRINKLER ROOM	25 HP 480/3	UTIL XFMR	1 3/4"	EMT 3	8 AWG		10 AWG	CU THH	N MECH	MECH		MTR	ELEC	ELEC	FS	60A	MTR	MECH	REFER TO SPECIFICATIONS FOR ADDITIONAL REQUIREMENTS	FP-1
FP-2	FIRE JOCKEY PUMP	MECHANICAL & FIRE SPRINKLER ROOM	1.5 HP 208/3	DP-CH11	1 3/4"	EMT 3	12 AWG		12 AWG	CU THH	N MECH	MECH		MTR	ELEC	ELEC	FS	30A	MTR	MECH	REFER TO SPECIFICATIONS FOR ADDITIONAL REQUIREMENTS	FP-2
			E D E L L D D			- FNT - O	40.414/0		10 11110						51.50	51.50	50			NEOL		0011.4
CRU-1 CRU-2	COMPUTER ROOM UNIT COMPUTER ROOM UNIT	SERVER HVAC & FIRE EQUIP SERVER HVAC & FIRE EQUIP	5.6 FLA 480/3 5.6 FLA 480/3		1 3/4" 1 3/4"		12 AWG 12 AWG		12 AWG 12 AWG	CU THH					ELEC	ELEC	FS FS	30A 30A	MTR MTR	MECH MECH		CRU-1 CRU-2
		SERVER TIVAG & FIRE EQUIP	5.0 FLA 400/5	DF-COITID	1 3/4		12 AVVG		12 AWG		N					ELEC	15	30A	WITK	MEGH		010-2
CU-1	CONDENSING UNIT	ROOF	5.6 FLA 480/3	DP-CH11	1 3/4"	EMT 3	12 AWG		12 AWG	CU THH	N				ELEC	ELEC	FS	30A	MTR	MECH		CU-1
CU-2	CONDENSING UNIT	ROOF	5.6 FLA 480/3	DP-CH11	1 3/4"	EMT 3	12 AWG		12 AWG	CU THH	N				ELEC	ELEC	FS	30A	MTR	MECH		CU-2
EF-1	EXHAUST FAN	ROOF	1/4 HP 120/1	CL13	1 3/4"		12 AWG	12 AWG	12 AWG	CU THH		ELEC		MTR	ELEC	ELEC	MMS	15A	MTR	MECH		EF-1
EF-2 EF-3	EXHAUST FAN EXHAUST FAN	ROOF ROOF	1/2 HP 120/1 1/4 HP 120/1	CL13 PL-20	1 3/4" 1 3/4"		12 AWG 12 AWG	12 AWG 12 AWG	12 AWG 12 AWG	CU THH		ELEC		MTR MTR	ELEC	ELEC	MMS MMS	15A 15A	MTR MTR	MECH MECH		EF-2 EF-3
EF-4	EXHAUST FAN	ROOF	1/4 HP 120/1	PL-20	1 3/4"		12 AWG	12 AWG	12 AWG	CU THH		ELEC		MTR	ELEC	ELEC	MMS	15A	MTR	MECH		EF-4
WH-1	WATER HEATER	MECHANICAL & FIRE SPRINKLER ROOM	67 MCA 208/1	DP-CL10	1 3/4"	EMT 2	4 AWG		8 AWG	CU THH	N				ELEC	ELEC	MMS	70A	MTR	MECH		WH-1
WH-2	WATER HEATER	MECHANICAL & FIRE SPRINKLER ROOM	67 MCA 208/1	DP-CL10	1 3/4"	EMT 2	4 AWG		8 AWG	CU THH	N				ELEC	ELEC	MMS	70A	MTR	MECH		WH-2
HOIST	HOIST	MEZZANINE	1 HP 208/1	PL20	1 3/4"	EMT 2	12 AWG		12 AWG	CU THH	N MFR	MFR		MTR	ELEC	ELEC	MMS	15A	MTR	MECH		HOIST
CUH-1	CABINET UNIT HEATER	SPRINKLER RM	0.68 FLA 120/1	CL-14	1 3/4"	EMT 2	12 AWG	12 AWG	12 AWG	CU THH	N				ELEC	ELEC	MMS	15A	MTR	MECH		CUH-1
CUH-2	CABINET UNIT HEATER	STAFF ENTRY VESTIBULE	.2 KVA 120/1	CL-12	1 3/4"		12 AWG	12 AWG	12 AWG	CU THH					ELEC	ELEC	MMS	15A	MTR	MECH		CUH-2
CUH-3	CABINET UNIT HEATER	ENTRY VESTIBULE	1/2 HP 120/1	CL-12	1 3/4"	EMT 2	12 AWG	12 AWG	12 AWG	CU THH	N ELEC	ELEC		MTR	ELEC	ELEC	MMS	15A	MTR	MECH		CUH-3
CUH-4	CABINET UNIT HEATER	HALLWAY	1/4 HP 120/1	PL-11	1 3/4"	EMT 2	12 AWG	12 AWG	12 AWG	CU THH	N ELEC	ELEC		MTR	ELEC	ELEC	MMS	15A	MTR	MECH		CUH-4
		NEOLBOOM					40.412/0		40 41410					LITE	FI E O	FLED	50	004	LITE	NEOU		
H-1 H-2	HUMIDIFIER	MECH ROOM MECH ROOM	18 FLA 480/3 18 FLA 480/3		1 3/4" 1 3/4"		12 AWG 12 AWG		12 AWG 12 AWG	CU THH		MFR		MTR	ELEC	ELEC	FS FS	30A 30A	MTR MTR	MECH MECH		H-1 H-2
H-2 H-3	HUMIDIFIER	MECH ROOM	10.8 FLA 480/3	PH20	1 3/4		12 AWG 12 AWG		12 AWG 12 AWG	CU THH				IVI I TA	ELEC	ELEC	FS FS	30A 30A	MTR	MECH		H-2 H-3
WT-1	WATER TREATMENT SYSTEM	MECH ROOM	5.5 FLA 120/1	CL10	1 3/4"		12 AWG	12 AWG	12 AWG	CU THH					ELEC	ELEC	MMS	15A	MTR	MECH		WT-1
WT-3	WATER TREATMENT SYSTEM	MEZZANINE	5.5 FLA 120/1	PL20	1 3/4"	EMT 2	12 AWG	12 AWG	12 AWG	CU THH					ELEC	ELEC	MMS	15A	MTR	MECH		WT-3
UH-1	UNIT HEATER	HALLWAY	1.3 FLA 120/1	CL10	1 3/4"	EMT 2	12 AWG	12 AWG	12 AWG	CU THH	N				ELEC	ELEC	MMS	15A	MTR	MECH		UH-1
FC-1	FAN COIL	01650C UPS EQUIP ROOM	9.6 FLA 120/1	CL10	1 3/4"	EMT 2	12 AWG	12 AWG	12 AWG	CU THH	N				ELEC	ELEC	MMS	15A	MTR	MECH		FC-1
FC-1	FAN COIL FAN COIL	01400A AV ROOM	9.6 FLA 120/1		1 3/4			12 AWG 12 AWG	12 AWG 12 AWG						ELEC	ELEC	MMS	15A	MTR	MECH		FC-1
NG-1C	NITROGEN GENERATOR COMPRESSOR	MECH 01650	2 HP 208/3	DP-CL10	1 3/4"	EMT 3	12 AWG		12 AWG	CU THH	N NONE	NONE		MTR	MECH	ELEC	NFS		MTR	MECH	REFER TO DRY TYPE SYSTEM DETAIL FOR MORE INFORMATION.	NG-1C
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A. ALL FUSE SIZES/BREAKER TRIPS ARE ESTIMATED. CONTRACTOR TO FIELD VERIFY INSTALLED MOTOR REQUIREMENTS.

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KEYED NOTES: 1. ELEVATOR GROUND SHALL BE FULLY SIZED.

0/1213105 - Lake County - New 911 EOC Facility/213105 - New 911-EOC Facility- (C21) rv 1 810 360/1213105 - Lake County - New 911 EOC Facility/213105 - New 911-EOC Facility- (C2 123 11:00:36 AM А

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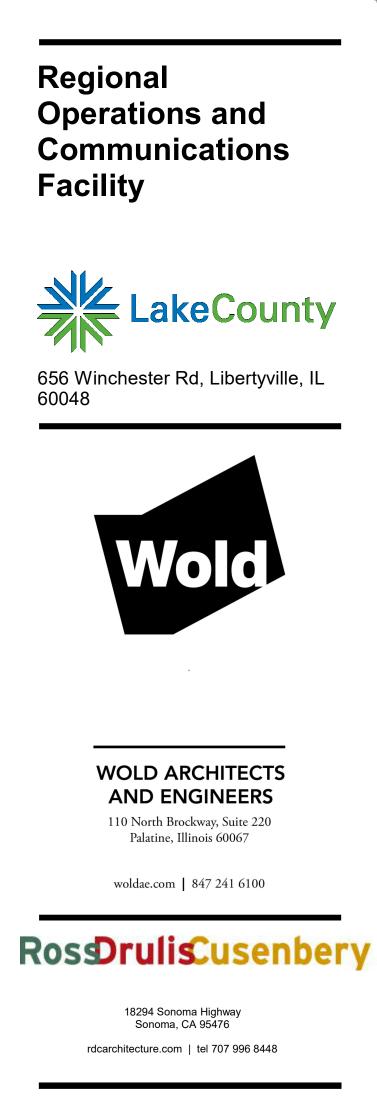
GENERA	L SCHEDULE NOTES

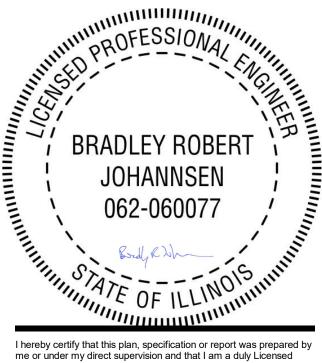
- A. OBTAIN SHOP DRAWINGS OF EQUIPMENT AND COMPARE CONNECTION, LOAD, AND VOLTAGE INFORMATION TO CONTRACT DOCUMENTS BEFORE INSTALLING FEEDER CONDUITS. NOTIFY ARCHITECT OF ANY DISCREPANCIES. BEFORE MAKING EQUIPMENT POWER CONNECTIONS, COMPARE EQUIPMENT NAMEPLATE DATA TO SHOP DRAWINGS AND CONTRACT DOCUMENTS. NOTIFY ARCHITECT/ENGINEER OF ANY DISCREPANCIES.
- B. SIZE OVERLOAD PROTECTION BASED ON ACTUAL NAMEPLATE DATA OF EQUIPMENT.
- C. MANUAL MOTOR STARTERS (MMS) TO BE SQUARE D FRACTIONAL HP MANUAL STARTERS WITH MELTING ALLOY TYPE THERMAL OVERLOAD OR APPROVED EQUAL. PROVIDE TOGGLE SWITCH WITH HANDLE GUARD AND RED PILOT LIGHT.
- D. WHEN STARTERS ARE PROVIDED BY ELEC PROVIDE A NON-REVERSING FVNR COMBINATION STARTER WITH FUSIBLE DISCONNECT UNLESS NOTED OTHERWISE. PROVIDE 120V CONTROL CIRCUIT WITH TRANSFORMER, (2) AUXILIARY CONTACTS, HOA SELECTOR SWITCH AND RED RUNNING PILOT LIGHT.

TYPE	DESCRIPTION	FACEPLATE	COVER
FB1	4-GANG RECESSED DUAL SERVICE FLOORBOX	(1) QUAD OUTLET	FLUSH, FLANGED LID
	WIREMOLD RFB4 SERIES OR APPROVED EQUAL	REFER TO SIGNAL/AV PLANS FOR	STANDARD FINISH TBD SUITABLE FOR CARPET INSTALLATION
	CONFERENCE ROOMS SLAB ON GRADE	DEVICES	PROVIDE SILICON BEAD AROUND OUTER E COVER TO SEAL FROM MOISTURE
RFB1	4-GANG RECESSED DUAL SERVICE FLOOR BOX	(1) QUAD OUTLET	FLUSH, FLANGED LID
	WIREMOLD EVOLUTION EFB45 SERIES OR APPROVED EQUAL	REFER TO SIGNAL/AV PLANS FOR DEVICES	STANDARD FINISH TBD SUITABLE FOR CARPET INSTALLATION PROVIDE SILICON BEAD AROUND OUTER E
	CONFERENCE ROOM RAISED PRESSURIZED FLOOR		COVER TO SEAL FROM AIR PRESSURE
RFB2	8-GANG RECESSED DUAL SERVICE FLOOR BOX	(2) QUAD OUTLET	FLUSH, FLANGED LID
	WIREMOLD EVOLUTION EFB8 SERIES OR APPROVED EQUAL	REFER TO SIGNAL/AV PLANS FOR DEVICES	STANDARD FINISH TBD SUITABLE FOR CARPET INSTALLATION PROVIDE SILICON BEAD AROUND OUTER E COVER TO SEAL FROM AIR PRESSURE
	EOC RAISED PRESSURIZED FLOOR		COVER TO SEAL TROW AIR FRESSORE
RFB3	10-GANG RECESSED DUAL SERVICE FLOOR BOX	(3) QUAD OUTLET	FLUSH, FLANGED LID STANDARD FINISH TBD
	WIREMOLD EVOLUTION EFB10 SERIES OR APPROVED EQUAL	REFER TO SIGNAL/AV PLANS FOR DEVICES	SUITABLE FOR CARPET INSTALLATION PROVIDE SILICON BEAD AROUND OUTER E COVER TO SEAL FROM AIR PRESSURE
	DISPATCH CONSOLE RAISED PRESSURIZED FLOOR		
\sim			
RFB4	2-GANG RECESSED DUAL SERVICE FLOOR BOX FURNITURE FEED WIREMOLD EVOLUTION EFBFF SERIES OR APPROVED EQUAL EOC RAISED PRESSURIZED FLOOR	NA	FURNITURE FEED COVER STANDARD FINISH TBD SUITABLE FOR CARPET INSTALLATION PROVIDE SILICON BEAF AROUND OUTER EDGE OF COVER TO SEAL FROM AIR PRESSURE
B. Contrac C. Provide D. Provide	TES TOR TO REQUEST DIMENSIONING OF FLOORBOXES FROM CTOR TO VERIFY FLOOR TYPE PRIOR TO ORDERING. CONDUIT FOR POWER AND ROUTE AS REQUIRED. APPROPRIATE CONDUIT FOR LOW VOLTAGE AND ROUTE DEVICES AND PLATES AS INDICATED ON PLANS AND SPEN	TO NEAREST ACCESSIBLE CEILING SPACE	

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I hereby certify that this plan, specification or report was prepared by me or under my direct supervision and that I am a duly Licensed **PROFESSIONAL ENGINEER** under the laws of the State of **ILLINOIS**

License BRADLEY R. JOHANNSEN Number: 062.060077 Date 12/30/2022

Revisions											
Description	Date	Num									
Addendum #2	2/24/2023	1									

E6.02

Comm: 213106 Date: 12/30/2022 Drawn: I.SHENO Check: B.JOHANNSEN



				PA	١N	EL	BC)A	RE): (CH	10						
		LOCATION: MECHANIA MOUNTING: RECESSE MAINS TYPE: MLO MAINS AMPS: 100A BUS AMPS: 100A FED FROM: DP-CH10		RE SPRI	NKL	ER			A.F.C	6 E: 4	5KAI		/.3ø4	W.				
				D //D	_		ASE		ASE		ASE	_	DICD			DTION		
# 1	BT	LOAD DESCRIPTION WEST WING AREA A	LTG	BKR 20 A	P	А К 1.5	2.7	ВК	(VA	CF	(VA	P	BKR 20 A	LT LTG	LOAD DESCRI		BT	# 2
3		AREA'B' NORTH BAND	LTG	20 A	1	1.0		3.8	2.0			1	20 A	LTG	AREA 'A' NORTH E	-		4
5		SPARE		20 A	1					0.0	0.7	1	20 A	LTG	CLERESTORY LTO	GS ARE		6
7		SPARE		20 A	1	0.0	0.0				-	1	20 A		SPARE			8
9		SPARE		20 A	1			0.0	0.0			1	20 A		SPARE			10
11		SPARE		20 A	1					0.0	0.0	1	20 A		SPARE			12
13		SPARE		20 A	1	0.0	0.0					1	30 A		SPARE			14
15		SPARE		20 A	1			0.0	0.0			2	20 A		SPARE			16
17		SPARE		20 A	1					0.0	0.0							18
19		SPARE		20 A	1	0.0	0.0					3	20 A		SPARE			20
21		SPARE		20 A	1			0.0	0.0									22
23		SPARE		20 A	1					0.0	0.0							24
25																		26
27																		28
29																		30
31																		32
33																		34
35																		36
37																		38
39																		40
41																		42
				TAL LO		4 k			VA		VA							
		ASSIFICATION		TAL AM	PS:		' A Iand		A E	STIM	A Atec)			PANEL TOTALS	5		
LTG			10732				.00%			13415								
														EST	ONNECTED LOAD: IMATED DEMAND: ECTED CURRENT:	13415 VA		
					-										EMAND CURRENT:			
Kitc Brea	hen, aker 1	es (LT): COOL - Summer L MTR - Largest Motor, LT Jpes (BT): AF = Arc Fault g, NX = New Breaker For I	G -Lighti , GF = Gr	ng, MTF ound Fa	R - M ault (lotor, Circu	RCP	T-R	ecep	tacle		-						

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				PA	١N	EL	BC	DA	RD): (CL	12	1				
		LOCATION: SHIPPING MOUNTING: RECESSE MAINS TYPE: MLO MAINS AMPS: 200A		VING (S	SECU	JRE).			-	1	8KAI	-	/.3ø4'	W.			
		BUS AMPS: 200A FED FROM: CL11															
#	вт	LOAD DESCRIPTION	LT	BKR	Р		۹.	E	В		C	Р	BKR	LT	LOAD DESCRI	PTION BI	т #
1		HEALTH & WELLNESS	RCPT	20 A	1	0.7	0.7					1	20 A	RCPT	HEALTH & WELLN	ESS	2
3		HALLWAY, BUNK RM,	RCPT	20 A	1			1.4	1.4			1	20 A	RCPT	TRAINING/BREAK	RM	4
5		BREAK/LUNCH RM RCPT	RCPT	20 A	1					1.4	0.4	1	20 A	RCPT	GFI TOLIETS RCP	T	6
7		TOLIETS & J/C RCPT	RCPT	20 A	1	1.3	0.2					1	20 A	RCPT	TRAINING RCPT		8
9		TEAMING AREA RCPT	RCPT	20 A	1			1.4	0.8			1	20 A	RCPT	FRIDGE		1
11		RCPT	RCPT	20 A	1					0.4	0.8	1	20 A	RCPT	FRIDGE		1
13		FRIDGE	RCPT	20 A	1	0.8	1.0					1	20 A	RCPT	COPIER RCPT		1
15		FRIDGE	RCPT	20 A	1			0.8	0.2			1	20 A	RCPT	COFFEE MAKER		1
17		GFI KITCHEN RCPT	RCPT	20 A	1					0.5	1.0	1	20 A	RCPT	MICROWAVE		1
19		MICROWAVE	RCPT	20 A	1	1.0	0.2					1	20 A	RCPT	MW NURSING RM		2
21		BREAKRM GFCI	RCPT	20 A	1			0.5	0.4			1	20 A	RCPT	EXTERIOR RCPTS	;	2
23		UC REF NURSE RM	RCPT	20 A	1					0.2	1.0	1	20 A	RCPT	TREADMILL		2
25		TREADMILL	RCPT	20 A	1	1.0	1.2					1	20 A	MTR	CUH-3		2
27		GFI NURSING RM	RCPT	20 A	1			0.5	0.8			1	20 A	RCPT	VEND		2
29		COPIER	RCPT	20 A	1					0.2	1.4	1	20 A	RCPT	FB TEAMING ARE	۹	3
31		RCPT TV TRAINING	RCPT	20 A	1	0.2	0.0					1	20 A	MTR	MTR		3
33		RCPT TRAINING	RCPT	20 A	1			0.5	0.8			1	20 A	RCPT	VEND		3
35		RCPT TRAINING	RCPT	20 A	1					0.5	0.2	1	20 A	MTR	CUH-2		3
37																	3
39									0.0			1	20 A		SPARE		4
41											0.0	1	20 A		SPARE		4
43		SPARE		20 A	1	0.0	0.0					1	30 A		SPARE		4
45		SPARE		20 A	1			0.0	0.0			2	20 A		SPARE		4
47		SPARE		20 A	1					0.0	0.0						
49		SPARE		20 A	1	0.0	0.0					3	20 A		SPARE		5
51		SPARE		20 A	1			0.0	0.0								. 5
53		SPARE		20 A	1					0.0	0.0						-
			то	TAL LO	AD:	8 k	VA	10	kVA		XA VA						
				TAL AM	IPS:) A	L) A		Α					_	
L OA MTR			CONNEC 1400 V		-		/AND .43%			STIM 1700	ATED	,			PANEL TOTALS		
RCP			24360				53%			17180				C	ONNECTED LOAD:	25760 VA	
															ECTED CURRENT: EMAND CURRENT:		
	I. T	bes (LT): COOL - Summer	Cooling I	FI EV- E		itor I		Eauir			Evid			Croup	ding UEAT Winto	Unating KTC	211

= Existing, NX = New Breaker For Existing Panel, M = Metered NOTES:

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				D۸	NI	CI	Dſ	אר	DГ). [סר	C	L10					
		LOCATION: CRITICAL MOUNTING: SURFACE					.DC	VOI	LTAG	BE : 2		20 \	LIU /.3ø4					
		MAINS TYPE: MCB MAINS AMPS: 600A BUS AMPS: 600A FED FROM: TC1						SF	PECIA	AL: S	PD							
	рт			DKD	_				 		•	Б	PKD			DTION	вт	4
# 1	BT	LOAD DESCRIPTION FP-2	LT MTR	BKR 20 A	Р 3	-	A 5.6	E	3			Р 2	BKR 80 A	LT MTR	LOAD DESCRI WH-1	PTION	BT	# 2
3								0.8	5.6									4
5										0.8	5.6	2	80 A	MTR	WH-2			6
7		NORTH GATE	MTR	20 A	3	0.9	5.6											8
9								0.9	20.1			3	200 A	Other	CL11 / CL12			10
11										0.9	16.5				-			12
13		EV CHARGING	XX_S	40 A	2	3.1	23.0											14
15								3.1	3.9			3	100 A	Other	CL 10			16
17		EV CHARGING	XX_S	40 A	2					3.1	18							18
19						3.1	18											20
21		SHORE POWER	RCPT	30 A	1	••••		0.5	13.5			3		Spare				22
23		SHORE POWER	RCPT	20 A	1			0.0	10.0		14.0							24
25		SHORE POWER	XX_S	50 A	2	10	12.0			0.2	11.0							26
27						1.0	12.0	1.0										28
29		NG-1C	MTR	20 A	3			1.0		0.9								30
31					-	0.9				0.3								32
33						0.9		0.9										34
								0.9										
35																		36
37																		38
39																		40
41																		42
43																		44
45																		46
47																		48
49																		50
51																		52
53			то	TAL LO	<u>۸</u> ۵,	007		50 I		225	kVA							54
				TAL LO		237		41			80A 95 A							
	D CL	ASSIFICATION	CONNEC	TED			IAND		E		ATED				PANEL TOTALS	8		
FA HEA	т		0 VA 361960 V				00% .00%		1	0 V 5245				<u> </u>	ONNECTED LOAD:	511201 \//	<u> </u>	
			37396 V				.00%			5245 40183					IMATED DEMAND:			
Othe	r		20602 \				.00%		2	20602	2 VA			CONN	ECTED CURRENT:	1419 A		
RCP			78500 \				37%			44250				EST. DE	MAND CURRENT:	1583 A		
Spar XX 3		;	1000 V 14560 V				.00% .00%			1000 14560								
Load Kitc Brea	l Typ nen, ker 1 isting	es (LT): COOL - Summer L MTR - Largest Motor, L Types (BT): AF = Arc Fault g, NX = New Breaker For	Cooling, E 「G -Lightir ;, GF = Gro	ELEV- E ng, MTR ound Fa	k - M ult (itor, l lotor, Circu	EQ - I RCP it Inte	T - R	omen ecep	t, EX tacle	-Exis					-		

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1. PROVIDE METERING FOR WATER HEATER BRANCH CIRCUITS.

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		LOCATION: SPRINKLE	R SERV	PA		EL	BC						/.3ø4	\ \ /				
		MOUNTING: RECESSE MAINS TYPE: MCB MAINS AMPS: 200A BUS AMPS: 200A FED FROM: TC2							A.F.C		0KAI(-						
#	вт	LOAD DESCRIPTION	LT	BKR	Р		4	E	3		C	Р	BKR	LT	LOAD DESCRI	PTION	вт	#
1		VESDA	Other	20 A	1	1.0	0.7					1	20 A	RCPT	ROLL CALL ROOM	RCPT		2
3		CLEAN AGENT	Other	20 A	1			1.0	0.2			1	20 A	RCPT	QUIET RM GFI RC	PT		4
5		QUIET ROOM & CIRC	RCPT	20 A	1					0.7	0.7	1	20 A	RCPT	OPS WORK ROOM	1 RCPT		6
7		OPS MNGR OFFICE RCPT	RCPT	20 A	1	0.9	0.7					1	20 A	RCPT	SP BREAKROOM F	RCPT		8
9		TRAINING MNGR OFFIC	RCPT	20 A	1			0.9	0.7			1	20 A	RCPT	OPS. MNGR OFFIC	CE RCPT		10
11		CORRIDOR STRG	RCPT	20 A	1					1.3	0.9	1	20 A	RCPT	GFI COMM CENTE	R		12
13		TECH WORKSHOP RCPT	RCPT	20 A	1	1.4	0.7					1	20 A	RCPT	I.T. WORK RM RC	PT		14
15		TECH WORKSHOP RCPT	RCPT	20 A	1			1.3	2.2			1	20 A	RCPT				16
17		I.T. WORK RM RCPT	RCPT	20 A	1					0.7	1.1	1	20 A	RCPT	I.T. MNGR OFFICE	RCPT		18
19		EXTERIOR RCPT	RCPT	20 A	1	0.4	0.7					1	20 A	RCPT	SERVER HVAC & S	SERVER		20
21		SITE RCPT	XX_S	50 A	2			5.2	0.2			1	20 A	RCPT	CONVIENCE OUTL	ET ROOF		22
23										5.2	0.7	1	20 A	MTR	EF-1			24
25		EF-2	MTR	20 A	1	1.2	0.0					1	20 A	Other	CRD REEL TECH W	VRKSHOP		26
27		JUNCTION TECH	Other	20 A	1			0.0										28
29		CRD REEL TECH	Other	20 A	1					0.0	0.7	1	20 A	RCPT	EWC CIRC			30
31							1.0					1	20 A		TOWER			32
33		FRIDGE QUIET RM	RCPT	20 A	1			0.1	0.4			1	20 A	Other	EGRESS DOORS			34
35		WEST GATE	MTR	20 A	3					0.9	0.0	1	20 A	Other	JUNCTION TECH W	VRKSHOP		36
37						0.9	0.5					1	20 A	MTR	MECHOSHADES			38
39								0.9	0.5			1	20 A	MTR	MECHOSHADES			40
41		EGRESS DOORS	Other	20 A	1					0.2	0.5	1	20 A	MTR	MECHOSHADES			42
43		MECHOSHADES	MTR	20 A	1	0.5	0.0					1	30 A		SPARE			44
45		MECHOSHADES	MTR	20 A	1			0.5	0.0			2	20 A		SPARE			46
47		SPARE		20 A	1					0.0	0.0							48
49		SPARE		20 A	1	0.0	0.0					3	20 A		SPARE			50
51		SPARE		20 A	1			0.0	0.0									52
53		SPARE		20 A	1					0.0	0.0							54
				TAL LO	-	11	kVA	14	κVΑ		kVA							1
				TAL AM	IPS:) A	L	7 A		4 A	<u> </u>						
L OA MTF		ASSIFICATION	CONNEC 7100 V				IAND .51%			STIM 7775	ATED)			PANEL TOTALS	5		
Othe			2460 V				.00%			2460				C	ONNECTED LOAD:	37405 VA		
RCF			17192				08%			13596					IMATED DEMAND:			
Spa xx	re SPE0	2	1000 V 10400 V				.00% .00%			1000 10400					ECTED CURRENT: EMAND CURRENT:			
<u> </u>	5, 20	-	10-100			100	.0070									5071		

Breaker Types (BT): AF = Arc Fault, GF = Ground Fault Circuit Interrupt, GE = Ground Fault Equipment Protection (30mA), SH = Shunt Trip, EX = Existing, NX = New Breaker For Existing Panel, M = Metered NOTES:

1. PROVIDE METERING FOR EXHAUST FAN BRANCH CIRCUITS.

		LOCATION: SHIP MOUNTING: RECE MAINS TYPE: MLO MAINS AMPS: 200A BUS AMPS: 200A FED FROM: DP-C	ESSED	RECEI	PA /ING (S				VOI	_TAG A.F.C.	E: 20	08Y/1 8KAI0	20 V C	/. 3 ø 4 OUGH					
#	B	T LOAD DESCRIPT	ON	ĹĨ	BKR	P	\sim	4	E	3	C	:	Р	BKR	LT	LOAD DESCRI	PTION	вт	#
1	_	SPARE	~ ~ ~ ~		20 A	1	0.0	0.7					1	20 A		GFI MECHANICAL			2
3	_	BREAKOUT RM		RCPT	20 A	Ύ			1.4	1.3			1	20 A		LOADING & RECO			4
5	_	BREAKOUT RM		RCPT	20 A	1					0.9	0.7	1	20 A		VESTIBULE & ELE	C RM		6
7	_	EOC & MEDICAL		RCPT	20 A	1	1.3	0.9					1	20 A		RADIO RM RCPT			8
9	_	FACILITY OPERATIC		RCPT	20 A	1			0.9	0.9			1	20 A		EMERGENCY OPE			10
11	_	COFFEE AREA GFI F		RCPT	20 A	1					0.4	1.1	1	20 A		EMERGENCY OPE	RATION		12
13		BREAKOUT RM - OP		RCPT	20 A	1	1.4	0.4					1	20 A		EXTERIOR RCPT			14
15	' m	EGRESS DOORS	r r	Other	20 A	1	\sim	\sim	0.2	1.0	\sim	\sim		20 A		COPIER COPY CE	<u>rrr</u>		16
17	_	FB EMERGENCY		Other	20 A	1	0.0	0.0			2.8	0.2	1	20 A		EXT STAGING REC			18
19	_	SPARE			20 A	1	0.0	2.8	0.0	0.0			1	20 A		FB EMERGENCY.			20
21	_	SPARE			20 A	1			0.0	0.0	0.0		1	20 A		SPARE			22
23	_	FB EMERGENCY		Other	20 A	1	0.0	0.0			2.8	2.8	1	20 A		FB EMERGENCY.			24
25	_	FB EMERGENCY		Other	20 A	1	2.8	0.0	0.0	0.0			1	20 A		SPARE			26
27	_			RCPT	20 A	1			0.2	0.0	0.4	0.0	1	20 A		SPARE			28
29	_			RCPT	20 A	1	1.0	1.1			0.4	2.8	1	20 A		FB EMERGENCY			30
31		NE GATE CAMERA	m	Other RCPT	20 A 20 A	1	1.0		1.0	~~~	\sim	\square		20 A 20 A		BREAKOUT RM SPARE	·	h	32 34
	_					1			1.0	0.0	1.0	0.0	1		<u> </u>				
35	_	MEDIA PEDESTAL SPARE		Other	20 A	1	0.0	0.0			1.0	0.0	1	20 A		SPARE SPARE			36 38
37	_	SPARE			20 A 20 A	1	0.0	0.0	0.0	0.0			1	20 A 20 A		SPARE			38 40
41	_	SPARE			20 A	1			0.0	0.0	0.0	0.0	1	20 A		SPARE			40
41	_	SPARE			20 A	1	0.0	0.0			0.0	0.0	1	30 A		SPARE			42
45	_	SPARE			20 A	1	0.0	0.0	0.0	0.0			2	20 A		SPARE			44
40	_	SPARE			20 A	1			0.0	0.0	0.0	0.0							40
49	_	SPARE			20 A	1	0.0	0.0			0.0	0.0	3	20 A		SPARE			50
51	_	SPARE			20 A	1	0.0	0.0	0.0	0.0									52
53	_	SPARE			20 A	1			0.0	0.0	0.0	0.0							54
				то	TAL LO		20	kVA	16	κVA	23								
						PS:		2 A Iand	137			7 A Ated				PANEL TOTALS			
MT		CLASSIFICATION		1400 V				.43%			1700					PANEL TOTAL	5		
	her			18565 \				.00%			8565					ONNECTED LOAD:			
RC	PT			40400 \	/A		62.	38%		2	5200	VA				IMATED DEMAND: ECTED CURRENT:			
-																EMAND CURRENT:			
Kit Bre	tche eake	ypes (LT): COOL - Sum n, L MTR - Largest Moto r Types (BT): AF = Arc ing, NX = New Breaker	or, LTG Fault, G	-Lightin F = Gro	ng, MTF ound Fa	R - M ault (lotor, Circu	RCP	'T - R	ecept	tacle		-				•		

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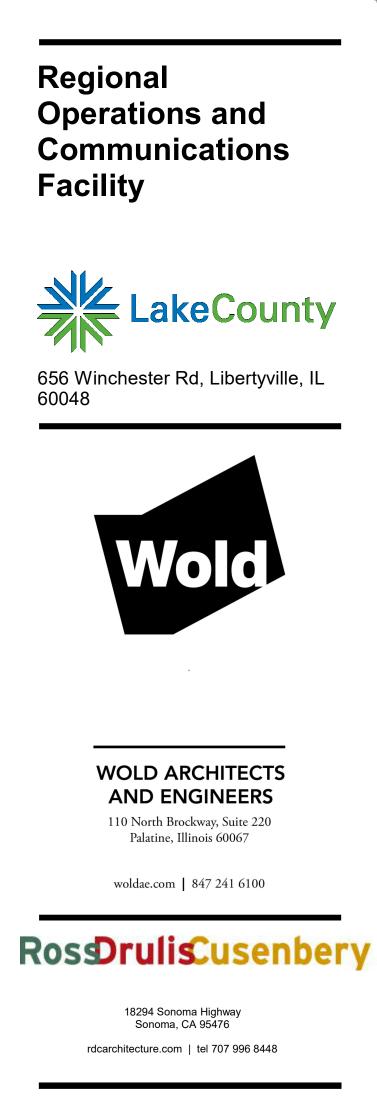
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		LOCATION: HALLWAY	01510		\ \): (√.3ø4	Ŵ				
		MOUNTING: SURFACE								1			v. o ø +					
		MAINS TYPE: MLO								AL: S		0						
		MAINS AMPS: 100A						0.	_0.,									
		BUS AMPS: 100A																
		FED FROM: DP-CL10																
#	вт	LOAD DESCRIPTION	LT	BKR	Р		4	E	3		2	Р	BKR	LT	LOAD DESCRI	PTION	вт	ŧ
1		CIRCULATION 01320	RCPT	20 A	1		1.0				-	1	20 A	RCPT	COMM. CENTER			2
3		COMM. CENTER WORK.	. RCPT	20 A	1			1.0	1.0			1	20 A	RCPT	COMM. CENTER	NORK		4
5		COMM. CENTER WORK.	. RCPT	20 A	1					1.0	1.0	1	20 A	RCPT	COMM. CENTER	NORK		6
7		COMM. CENTER WORK.	. RCPT	20 A	1	1.0	1.0					1	20 A	RCPT	COMM. CENTER	NORK		8
9		COMM. CENTER WORK.	. RCPT	20 A	1			1.0	0.7			1	20 A	RCPT	COMM. CENTER	RCPT		1
11		COMM. CENTER	RCPT	20 A	1					1.0	1.0	1	20 A	RCPT	COMM. CENTER	RCPT		1
13		COMM. CENTER	RCPT	20 A	1	1.7	1.0					1	20 A	RCPT	COMM. CENTER	WORK		1
15		COMM. CENTER WORK.	. RCPT	20 A	1			1.3	1.0			1	20 A	RCPT	COMM. CENTER	NORK		1
17		COMM. CENTER WORK.	. RCPT	20 A	1					1.0	1.0	1	20 A	RCPT	COMM. CENTER	WORK		1
19		COMM. CENTER	RCPT	20 A	1	1.0	1.0					1	20 A	RCPT	RCPTCOMM. CEN	TER		2
21		COMM. CENTER	RCPT	20 A	1			1.0	1.0			1	20 A	RCPT	COMM. CENTER	NORK		2
23		COMM. CENTER	RCPT	20 A	1					1.0	1.0	1	20 A	RCPT	COMM. CENTER	NORK		2
25		COMM. CENTER WORK.	. RCPT	20 A	1	1.0	1.0					1	20 A	RCPT	COMM. CENTER	NORK		2
27		RCPTCOMM. CENTER	RCPT	20 A	1			1.0	1.0			1	20 A	RCPT	COMM. CENTER	NORK		2
29		RCPTCOMM. CENTER	RCPT	20 A	1					1.0	1.0	1	20 A	RCPT	COMM. CENTER	NORK		3
31		COMM. CENTER WORK.	. RCPT	20 A	1	1.0	1.0					1	20 A	RCPT	COMM. CENTER	NORK		3
33		COMM. CENTER	RCPT	20 A	1			1.0	1.0			1	20 A	RCPT	COMM. CENTER	NORK		3
35		COMM. CENTER	RCPT	20 A	1					1.0	1.0	1	20 A	RCPT	COMM. CENTER	NORK		3
37		COMM. CENTER WORK.	. RCPT	20 A	1	1.0	0.1					1	20 A	MTR	CUH-1			3
39		MECHOSHADES	MTR	20 A	1			1.0	1.0			1	20 A	MTR	MECHOSHA	DES		4
41		SPARE		20 A	1					0.0	0.0	1	20 A		SPARE			4
43		SPARE		20 A	1	0.0	0.0					1	20 A		SPARE			4
45		SPARE		20 A	1			0.0	0.0			1	20 A		SPARE			4
47		SPARE		20 A	1					0.0	0.0	1	20 A		SPARE			4
49		SPARE		20 A	1	0.0	0.0					1	20 A		SPARE			5
51		SPARE		20 A	1			0.0	0.0			1	20 A		SPARE			5
53		SPARE		20 A	1					0.0	0.0	1	20 A		SPARE			5
				TAL LO			kVA		kVA	12								
		LASSIFICATION			IPS:		5 A Iand		8 A F	100 100) A Ater				PANEL TOTALS	<u> </u>		
MTR			2100 V				.90%			2350		•						
RCP	Τ		37420	VA		63.	36%		2	23710	VA				ONNECTED LOAD:			
															IMATED DEMAND: ECTED CURRENT:			
															EMAND CURRENT:			
		pes (LT): COOL - Summer L MTR - Largest Motor, L1										sting	g, GND	- Groun	ding, HEAT - Winte	r Heating, K	TCF	-1-
		Types (BT): AF = Arc Fault										d Fa	ult Faui	inment l	Protection (30mA)	SH = Shunt	Trir	n (

CH10	DP-CL10	CL11
CL12	CL13	CL14





I hereby certify that this plan, specification or report was prepared by me or under my direct supervision and that I am a duly Licensed PROFESSIONAL ENGINEER under the laws of the State of ILLINOIS

License BRADLEY R. JOHANNSEN Number: 062.060077 Date 12/30/2022

Revisions											
Description	Date	Num									
Addendum #2	2/24/2023	1									

Comm: 213106 Date: 12/30/2022 Drawn: **R.HINKS** Check: **B.JOHANNSEN**



E6.12

				PA	١N	EL	.BC	C	R): F	PH	21						
		LOCATION:						vo	LTAG	6E : 4	80Y/2	<u>277</u> ۷	V.3ø4	W.				
		MOUNTING: SURFACE							A.F.C	s	EE S	HOF	RT CIRC	UIT ST	UDY			
		MAINS TYPE: MLO						SF	PECIA	AL:								
		MAINS AMPS: 100A																
		BUS AMPS:																
		FED FROM: PH20																
#	вт	LOAD DESCRIPTION	LT	BKR	Р		ASE 〈VA		ASE 〈VA		ASE (VA	Р	BKR	LT	LOAD DESCRI		вт	#
		AREA 'A' SOUTH BAND/	LTG	20 A	1	1.7	0.4					1	20 A	LTG	MEZZANINE MECH			7 2
3		AREA 'A' SOUTH BAND/	LTG	20 A	1		0.1	1.3	0.0			1	20 A		SPARE			4
5		AREA 'B' SOUTH BAND	LTG	20 A	1			1.0	0.0	2.3	0.0	1	20 A		SPARE			6
7		SPARE		20 A	1	0.0	0.0			2.0	0.0	1	20 A		SPARE			8
9		SPARE		20 A	1	0.0	0.0	0.0				-	2077					10
11		SPARE		20 A	1			0.0		0.0								10
13				20 7	1					0.0								14
15																		14
13																		18
19																		20
21																		20
21												-						22
23			то	TAL LO		2 k	(VA	1 k	(VA	2 k	ΧA							24
				TAL AM			A		A		A							
LOA	D CL	ASSIFICATION		TED		DEN	AND)	E	STIM	ATEC)			PANEL TOTAL	S		
LTG			5752 \	/A		125	6.00%			7190	VA			-		5750 \ /A		
															CONNECTED LOAD: TIMATED DEMAND:			
															NECTED CURRENT:			
															EMAND CURRENT:			

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		LOCATION: HALLW MOUNTING: RECES MAINS TYPE: MLO MAINS AMPS: 200A BUS AMPS: 200A FED FROM: TP20 /	SSED						LTAG A.F.C PECIA	1			/. 3 ø 4	W.				
#	вт	LOAD DESCRIPTIO	N LT	BKR	Р		ASE (VA		ASE (VA	PH/	ASE XA	Р	BKR	LT	LOAD DESCRI	ρτιων	вт	#
" 1		01420 RCPT	RCPT	20 A	1	1.4						1	20 A		04120 RCPT			2
3		01420 RCPT	RCPT	20 A	1			1.4	1.1			1	20 A		01420G RCPT			4
5		01420F RCPT	RCPT	20 A	1					1.1	1.3	1	20 A		01420E RCPT			6
7		01420D RCPT	RCPT	20 A	1	1.1	0.4				1.0	1	20 A		COFFEE AREA 21	9 RCPT		8
9		01410B 01410A 01110		20 A	1		0.1	16	0.5			1	20 A		01420A RCPT			10
11		01110, 01100 RCPT	RCPT	20 A	1			1.0	0.0	1.3	0.5	1	20 A		01411 01412 01410			12
13		01420B 01150 RCPT	RCPT	20 A	1	0.7	0.2			1.0	0.0	1	20 A		COFFEE	00 01 1		14
15		EXTERIOR RCPT	RCPT	20 A	1	0.7	0.2	0.2	3.0			2			EV CHARGING			16
17		PLOTTER	RCPT	20 A	1			0.2	5.0	0.2	3.0		40 A					18
17		EXTERIOR RCPT	RCPT		1	0.2	0.2			0.2	3.0				 EGRESS DOORS			20
				20 A		0.2	0.2	2.0	0.2				20 A					
21		EV CHARGING	XX_S	40 A	2			3.0	0.3	2.0		1	20 A	Other	SOUND MASKING			22
23						0.0				3.0								-
25		SPARE		20 A	1	0.0		0.0	0.0						00405			26
27		SPARE		20 A	1			0.0	0.0			1	20 A		SPARE			28
29		SPARE		20 A	1					0.0	0.0	1	30 A		SPARE			30
31		SPARE		20 A	1	0.0	0.0					1	30 A		SPARE			32
33		SPARE		20 A	1			0.0	0.0			2	20 A		SPARE			34
35		SPARE		20 A	1					0.0	0.0							36
37		SPARE		20 A	1	0.0	0.0					3	20 A		SPARE			38
39		SPARE		20 A	1			0.0	0.0									40
41		SPARE		20 A	1					0.0	0.0							42
							VA		kVA	10								
			CONNEC	TAL AN			' A Nand	· · · · ·	' A F S		A Ated)			PANEL TOTALS	S		
Othe			488 V/		-		.00%			488								
RCP			14580 \				29%			2290					ONNECTED LOAD:			
XX_	SPEC	5	12064 \	/A	-	100	.00%		1	2064	VA	_			IMATED DEMAND: ECTED CURRENT:			
												_			ECTED CORRENT:			
					-													

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NOTES:

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				PA	١N	EL	.BC	DA	R): (CL	10						
		LOCATION: CRITICAL MOUNTING: SURFACE MAINS TYPE: MLO MAINS AMPS: 100		:OOM 0	1650	β		-		: S	SEE S	-	V. 3 ø 4 RT CIR(W. CUIT ST	JDY			
		BUS AMPS: 100 FED FROM: DP-CL10						1		1								
#	вт	LOAD DESCRIPTION	LT	BKR	Р		ASE (VA	1	ASE KVA		ASE (VA	Р	BKR	LT	LOAD DESCRI	PTION	вт	#
1		P-8	MTR	20 A	1	0.5	0.5					1	20 A	Other	AHU-1 UV			2
3		FIRE PUMP CP	Other	20 A	1			0.2	0.1			1	20 A	Other	AHU-1 AUX			4
5		PREACTION	Other	20 A	1					0.5	0.1	1	20 A	Other	AHU-2 AUX			6
7		AHU-2 UV	Other	20 A	1	0.5	0.0					1	20 A	FA	FACP			8
9		WT-1	MTR	20 A	1			0.7	1.0			1	20 A		TOWER			10
11		UH-1	MTR	20 A	1					0.2	0.2	1	20 A	Other	DRY TYPE SYSTE	M		12
13		FC-1	MTR	20 A	1	1.2	1.2					1	20 A	MTR	FC-2			14
15		NORTH DOWNSPOUTS	HEAT	20 A	2			1.1	17			2	20 A	HEAT	NORTH GUTTERS			16
17										1.1	17							18
19		SPARE		20 A	1	0.0	0.0					1	20 A		SPARE			20
21		SPARE		20 A	1			0.0	0.0			1	20 A		SPARE			22
23		SPARE		20 A	1					0.0	0.0	1	20 A		SPARE			24
25												-						26
27																		28
29																		30
31												-						32
33												-						34
35												-						36
37																		38
39												-						40
41																		40
41			то	TAL LC)AD:	4 k	(VA	183	kVA	182	kVA	-						42
			TO	TAL AN		33	3 A	175	53 A	174	14 A							
	AD CL	ASSIFICATION	CONNEC		_)	E)			PANEL TOTALS	S		
FA HEA	T		0 VA 361960				00% 0.00%		4	0 V 5245	0 VA			С	ONNECTED LOAD:	368796 VA	4	
MTF			3800 V				.89%			4100					IMATED DEMAND:			
Oth			2076 V				.00%			2076					ECTED CURRENT:			
Spa	re		1000 V	/A	-	100	.00%			1000	VA			EST. D	EMAND CURRENT:	1276 A		
					+													
Kito Bre	hen, aker	bes (LT): COOL - Summer L MTR - Largest Motor, L Types (BT): AF = Arc Faul g, NX = New Breaker For	TG -Lightin t, GF = Gro	ng, MTF ound Fa	R - N ault	lotor, Circu	, RCP lit Int	PT - R	Recep	tacle)							
PRO		METERING FOR FAN CO METERING FOR HEAT T																

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				PA	١N	EL	BC	DA	RE): F	ירכ	11					
		LOCATION:						VOI	LTAG	6E : 2	08Y/1	120	/.3ø4	W.			
		MOUNTING: RECES	SED						A.F.C	1	0KAI	С					
		MAINS TYPE: MLO						SP	PECIA	AL:							
		MAINS AMPS: 100A															
		BUS AMPS: 100A															
	1	FED FROM: TP20 /	GUTTER	1	1								1	1			
#	вт	LOAD DESCRIPTIO	N LT	BKR	Р		ASE (VA		ASE (VA		ASE (VA	Р	BKR	LT	LOAD DESCR	IPTION BT	#
1		ADMIN CONF RCPT	RCPT	20 A	1	1.1	0.7					1	20 A	RCPT	01245 GFI RCPT		2
3		01240G RCPT	RCPT	20 A	1			0.7	0.9			1	20 A	RCPT	01240E RCPT		4
5		01240F RCPT	RCPT	20 A	1					0.9	1.0	1	20 A	RCPT	PATIO		6
7		01240D RCPT	RCPT	20 A	1	0.9	0.9					1	20 A	RCPT	01240C RCPT		8
9	~	01240B RCPT	RCPT	20 A	1	\sim		0.9	1.6	\sim		1	20 A	RCPT	01220F RCPT		10
11		OPEN OFFICE	Other	20 A	1					1.0	0.2	1	20 A	RCPT	COFFEE MAKER	OPEN	12
13		01220E RCPT	RCPT	20 A	1	1.4	1.3	\sim	\sim			1	20 A	RCPT	01220B RCPT		14
15		01220D RCPT	RCPT	20 A	1			1.4	0.9			1	20 A	RCPT	01220 & 01220H R	CPT	16
17		01220C RCPT	RCPT	20 A	1				~~~	1.4	0.2	1	20 A	RCPT	COPIER 01220		18
19		01220A GFI	RCPT	20 A	1	0.4	1.0					1	20 A	Other	OPEN OFFICE FU	RNITURE	20
21		01220G RCPT	RCPT	20 A	1			1.1	0.2			1	20 A	RCPT	EXTERIOR RCPT		22
23		01210, 01240, 01213 R	CPT RCPT	20 A	1					1.3	0.2	1	20 A	RCPT	COFFEE MAKER	CONF RM	24
25		COPIER	RCPT	20 A	1	0.4	0.7					1	20 A	MTR	CUH-4		26
27		REF COFFEE AREA	RCPT	20 A	1			0.2	0.3			1	20 A	Other	SOUND MASKING		28
29		COFFEE MAKER COF	E RCPT	20 A	1					0.2	0.9	1	20 A	RCPT	01240G RCPTS		30
31							0.0			۲ ر	\sim	1	30 A	<u> </u>	SPARE	m	32
33									0.0			2	20 A		SPARE		34
35		SPARE		20 A	1					0.0	0.0						36
37		SPARE		20 A	1	0.0	0.0					3	20 A		SPARE		38
39		SPARE		20 A	1			0.0	0.0								40
41											0.0						42
				TAL LO			KVA	8 k			VA						
LOA		ASSIFICATION		TAL AM	F3.		3 A IAND	70		STIM) A Atec)			PANEL TOTAL	S	
MTR			700 V				.00%			875							
Othe			1908 \				.00%			1908					ONNECTED LOAD:		
RCP	۲		21520	VA		73.	23%		1	15760) VA				IMATED DEMAND: ECTED CURRENT:		
															EMAND CURRENT:		

NOTES:

				PA	١N	EL	B	C	RC): F	PH	20						
		LOCATION:						VO	LTAG	6E : 4	80Y/2	<u>277 ۱</u>	V.3ø4	W.				
		MOUNTING: SURFA	CE						A.F.C	1	0KAI	С						
		MAINS TYPE: MLO						SF	PECIA	AL:								
		MAINS AMPS: 200A																
		BUS AMPS: 200A																
		FED FROM: MSBH-1																
#	вт	LOAD DESCRIPTION	N LT	BKR	Р		ASE VA		ASE (VA		ASE (VA	Р	BKR	LT	LOAD DESCRI	PTION	вт	#
1		AHU-3: SF-1	MTR	20 A	3	3.0	3.0					3	20 A	MTR	AHU-3: SF-2			2
3	-							3.0	3.0									4
5										3.0	3.0							6
7		AHU-3:RF-1	MTR	20 A	3	1.3	1.3					3	20 A	MTR	AHU-3: RF-3			8
9								1.3	1.3									10
11										1.3	1.3							12
13		TP20 (PL10, PL11, PL20	0) Other	100 A	3	19.1	2.1					3	100 A	Spare	PH21			14
15								23.5	1.3									16
17										20.8	2.3							18
19		H-3	MTR	20 A	3	0.3	0.0					1	20 A		SPARE			20
21								0.3	0.0			1	20 A		SPARE			22
23										0.3	0.0	1	20 A		SPARE			24
25		SPARE		20 A	1	0.0	0.0					1	20 A		SPARE			26
27		SPARE		20 A	1			0.0										28
29		SPARE		20 A	1					0.0								30
31		SPARE		20 A	1	0.0												32
33		SPARE		20 A	1			0.0										34
35																		36
37																		38
39																		40
41																		42
				TAL LO		30	kVA 8 A	-	kVA 3 A		kVA 6 A							
LOA	D CL	ASSIFICATION	CONNEC		F O .	1	IAND	-			ATEC)			PANEL TOTALS	5		
HEA			4798 V	A		125	.00%	,		5998	VA							
LTG			5752 V	A		125	.00%			7190	VA			С	ONNECTED LOAD:	95560 VA		
MTF			34900 \				.52%			37175					IMATED DEMAND:			
Othe			2949 V				.00%	,		2949					ECTED CURRENT:			
RCF		、	36640 \				65%			23320				EST. DI	EMAND CURRENT:	105 A		
<u>^^</u>	SPEC	,	12064 \	/A		100	.00%	•		12064	i va							
Kitc Brea = Ex NOT	hen, iker 1 isting ES:	bes (LT): COOL - Summo L MTR - Largest Motor, Types (BT): AF = Arc Fa g, NX = New Breaker Fo METERING FOR EXHA	LTG -Lightin ult, GF = Gro or Existing P	ng, MTR ound Fa Panel, M	R - M ault (I = N	lotor, Circu letere	RCF it Int ed	PT - R	ecep	tacle								

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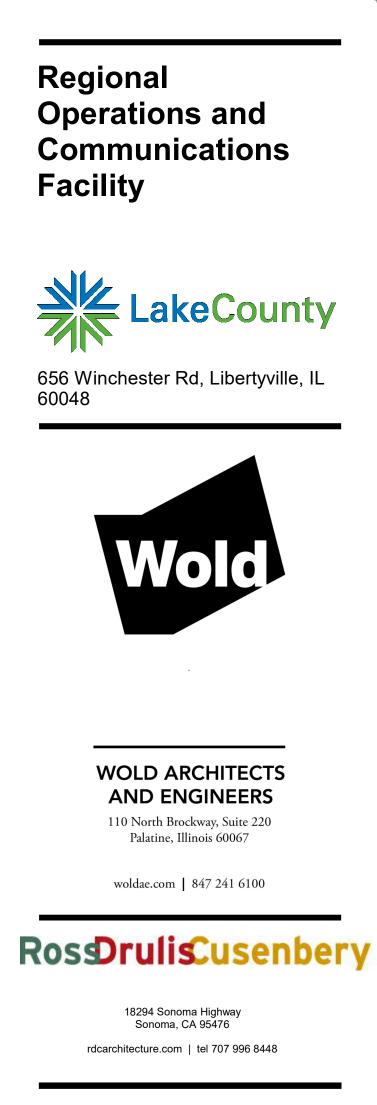
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				PA	١N	EL	.BC	DA	RE): F	בר בי	20						
		LOCATION:						vo	LTAG	5E : 2	08Y/	120	V.3ø4	W.				
		MOUNTING: SURFAC	E						A.F.C	1	0KAI	С						
		MAINS TYPE: MCB						SF	PECIA	AL:								
		MAINS AMPS: 60A																
		BUS AMPS: 60A																
	_	FED FROM: TP20 / G	UTTER															
#	вт	LOAD DESCRIPTION	LT	BKR	Р		ASE (VA		ASE (VA		ASE (VA	Р	BKR	LT	LOAD DESCRI	PTION	вт	#
1		RCPT	RCPT	20 A	1	0.2	0.7					1	20 A	MTR	EF-3			2
3		MEZZANINE RCPT	RCPT	20 A	1			0.4	1.7			3	20 A	MTR	HOIST			4
5		EF-4	MTR	20 A	1					0.7	1.7							6
7		AHU-3 UV	Other	20 A	1	0.5	1.7											8
9		AHU-3 AUX	Other	20 A	1			0.1	0.6			2	20 A	HEAT	SOUTH DOWNSPO	JUTS		10
11		WT-3	MTR	20 A	1					0.7	0.6							12
13		SOUTH GUTTERS	HEAT	20 A	2	1.8	0.0					1	20 A		SPARE			14
15								1.8	0.0			2	20 A		SPARE			16
17		SPARE		20 A	1					0.0	0.0							18
19		SPARE		20 A	1	0.0	0.0					3	20 A		SPARE			20
21		SPARE		20 A	1			0.0	0.0									22
23		SPARE		20 A	1					0.0	0.0							24
				TAL LO			νA	5 k	νA		νA							
					IPS:			_										
HEA		LASSIFICATION	CONNEC 4798 V		-		/AND			5998		,			PANEL TOTALS	>		
MTR			7100 V		-		.61%			8350				C	ONNECTED LOAD:	13038 VA		
Othe	er		600 V	4		100	.00%			600	VA			EST	IMATED DEMAND:	15488 VA		
RCP	T		540 V	Ą		100	.00%			540	VA				ECTED CURRENT:			
					-									EST. DE	EMAND CURRENT:	43 A		
Loa	d Tvi	pes (LT): COOL - Summer	r Coolina, I	ELEV- E	leva	tor.	EQ -	Εαυίι	omen	t. EX	-Exi	sting	a. GND	- Groun	dina. HEAT - Winte	r Heating.	KTCł	4-
Kitc	hen,	L MTR - Largest Motor, L	TG -Lightin	ng, MTF	R - M	lotor	, RCP	PT - R	lecep	tacle)							
		Types (BT): AF = Arc Fau ng, NX = New Breaker For						errup	ot, GE	= G	roun	d Fa	ult Equ	ipment I	Protection (30mA),	SH = Shur	nt Trip), EX
							~~											
		E METERING FOR EXHAU	IST FAN BF	RANCH	CIRC	CUIT	S.											
		E METERING FOR HEAT 1																

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PH21	CL10	PH20
PL10	PL11	PL20





I hereby certify that this plan, specification or report was prepared by me or under my direct supervision and that I am a duly Licensed **PROFESSIONAL ENGINEER**under the laws of the State of **ILLINOIS**

License BRADLEY R. JOHANNSEN Number: 062.060077 Date 12/30/2022

Revisions									
Date	Num								
2/24/2023	1								
	Date								

 Comm:
 213106

 Date:
 12/30/2022

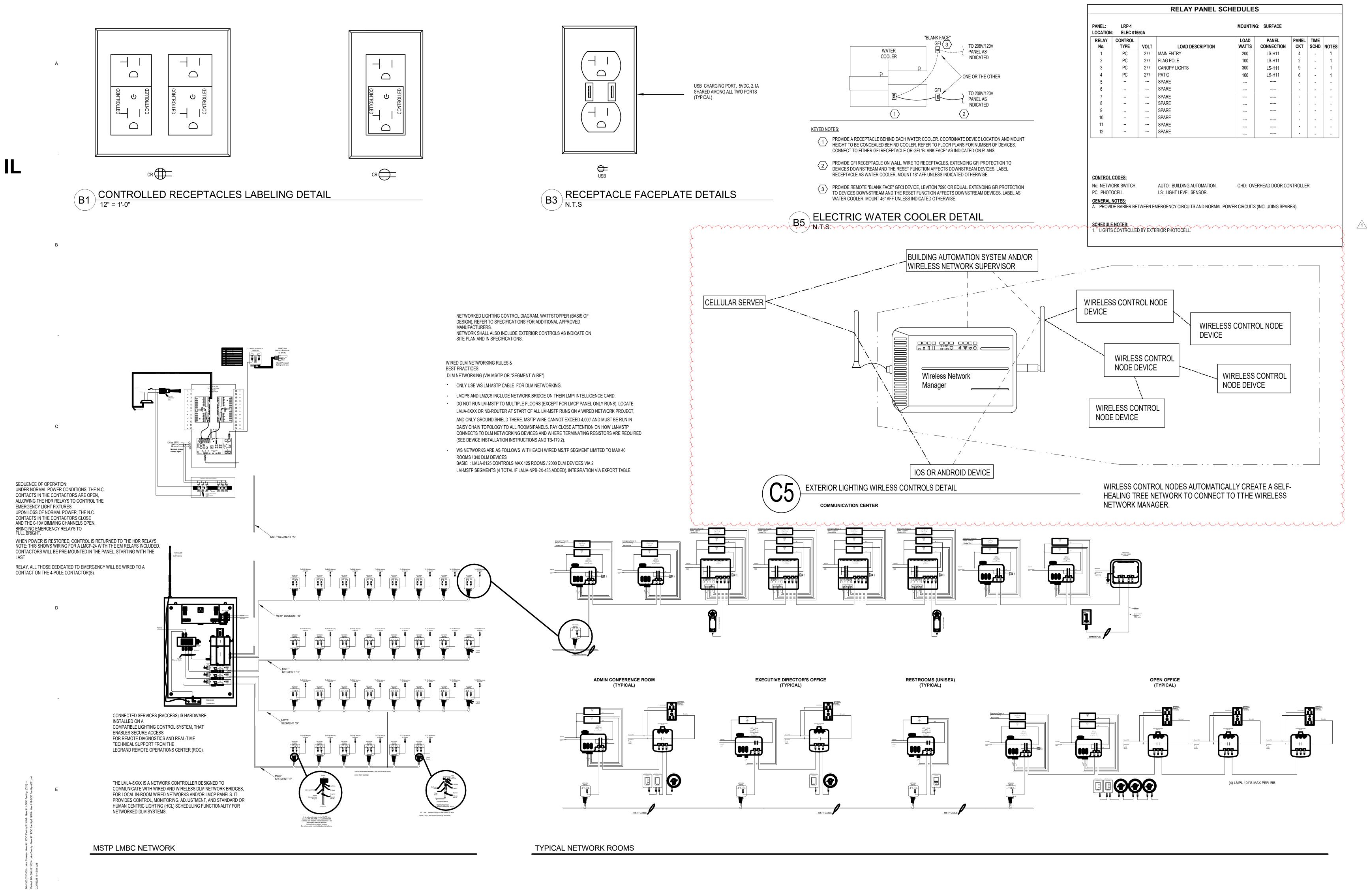
 Drawn:
 R.HINKS

 Check:
 B.JOHANNSEN



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Scale[.]



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X-29 NETWORK LIGHTING CONTROLS - SCHEMATIC ONE LINE DIAGRAM

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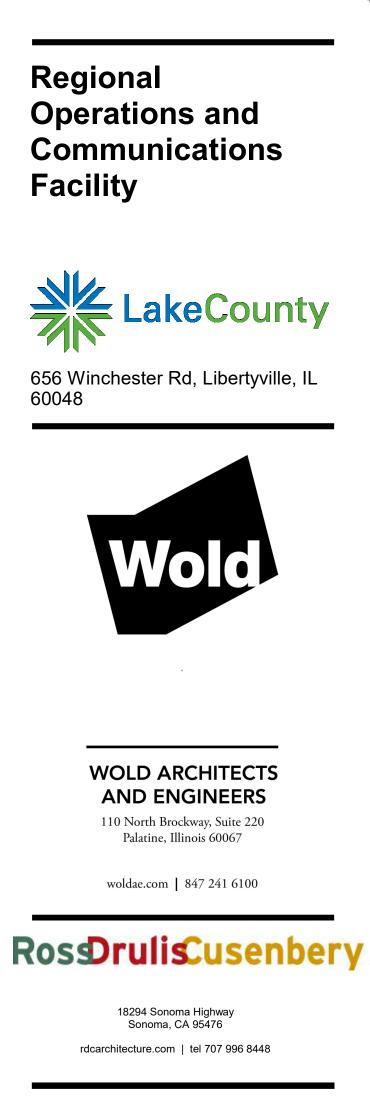
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Comm: 213106 Date: 12/30/2022 Drawn: Author Check: Checker	North	
ELECTRIC DETAILS	CAL	

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