ARTICLE 6 BID SCHEDULE

6.1 Base Bid Schedule - The Bidder will complete the Work and accept in full payment, for the Work items listed, the following unit prices and/or Bid Prices, as applicable:

Base Bid Item No.	Bid Quantity	Description	Unit Price	Item Bid Price
1	**1**	**Construction Contingency**	**$350,000**	**$350,000**
		ALLOWANCE AMOUNT		
TOTAL (This amount should equal the Base Bid amount on the Bid Summary Form)				**$**

Base Bid (Sum of Bid Prices for all Base Bid Items):

_____ Dollars and No/Cents $_____
(use words) (in figures)

Name of the Bidder _____ File No. _____

Date _____

SIGMA VENDOR NUMBER _____

Telephone No. _____

SECTION 074213.19
INSULATED METAL WALL PANELS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Factory-assembled metal panel system for walls, with trim, related flashings and accessory components.

1.02 REFERENCE STANDARDS

A. AAMA 609 & 610 - Cleaning and Maintenance Guide for Architecturally Finished Aluminum; 2025.

B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.

C. ASTM A792/A792M - Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process; 2023.

D. ASTM D1621 - Standard Test Method for Compressive Properties of Rigid Cellular Plastics; 2016 (Reapproved 2023).

E. ASTM D1622 - Standard Test Method for Apparent Density of Rigid Cellular Plastics; 2020.

F. ASTM E330/E330M - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference; 2014 (Reapproved 2021).

1.03 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide manufacturer documentation on tested structural, thermal, and fire resistance capabilities of assembled panel.

C. Shop Drawings: Indicate dimensions.

D. Samples: Submit two samples of panel, 3 x 5 inch (____x____ mm) in size illustrating finish color, sheen, and texture.

E. Design and Performance Data: Indicate panel profile and dimensions.

F. Manufacturer's qualification statement.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this Section with minimum three years documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Protect panels from accelerated weathering by removing or venting sheet plastic shipping wrap.

B. Store pre-finished material off ground with weather protection to prevent twisting, bending, or abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.

1.06 WARRANTY

A. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials and workmanship within specified warranty period.
   1. Warranty Period: Two years from date of Substantial Completion.

B. Special Warranty on Panel Finishes: Manufacturer’s standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
   1. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Insulated Metal Wall Panels:
   1. Kingspan Insulated Panels; Optimo: www.kingspan.com/#sle.
   2. Substitutions: See Section 016000 - Product Requirements.

2.02 PERFORMANCE / DESIGN CRITERIA

A. Metal Panel System: Factory-assembled metal panel system, with trim, related flashings and accessory components.
   1. Provide positive drainage to exterior for moisture entering or condensation occurring within panel system.
   2. Accommodate tolerances of building structural framing.

B. Performance Requirements:
   1. Thermal Performance: Provide thermal resistance through entire system; R-value (RSI-value) of ___ (___), minimum.
   2. Structural Performance: Design and size to withstand all dead loads and wind loads caused by positive and negative wind pressure acting normal to plane of panel.
      a. Verify structural performance in accordance with ASTM E330/E330M, using test pressure 1.5 times design wind pressure, with 10 seconds duration of maximum load.
      b. Maximum Allowable Deflection of Panel: 1/90 of span.
   3. Movement: Accommodate the movement caused by the following without damage to system, components, or deterioration of seals:
      a. Normal movement between system components.
      b. Seasonal temperature cycling.
      c. Deflection of structural support framing,

2.03 COMPONENTS

A. Wall Panels: Exterior and interior metal sheet skin, factory-assembled, with rock wool insulation; exterior and interior sheet interlocking at edges, fitted with continuous gaskets.

B. Trim, Closure Pieces, Expansion Joints, Caps, Flashings, Fascias, and Infills: Same material , thickness and finish as exterior sheets; factory-fabricated to required profiles; fabricated in longest practicable lengths.

2.04 PANELS AND TRIM

A. Wall Panels: Factory-assembled, foamed-in-place, insulated metal panels with exterior and interior sheet metal skins; panels interlock at edges
   1. Exterior Panel Face Profile: Flat
   2. Interior Panel Face Profile: Shadowline
   3. Panel thickness: 3 inches
   4. Exterior Sheet: Prefinished aluminum-zince-alloy-coated steel, 22 gauge, 0.0299 inch minimum base metal thickness
   5. Interior Sheet: Prefinished galvanized steel, 24 gauge, 0.0239 inch minimum base metal thickness
   6. Horizontal Joints Between Panels: 1/8 inch wide joint reveal.
   7. Vertical Joints Between Panels: 1/8 inch reveals
   8. Exterior Face of Panel Paint Finish: Two-coat, polyvinylidene fluoride 1.0 mil, 0.001 inch system; 0.2 mil, 0.0002 inch primer with 0.8 mil, 0.0008 inch Kynar 500 (70 percent) color coat.
      a. Color: Dark Bronze

2.05 ACCESSORIES

A. Support for Cladding and Continuous Insulation: Thermal clips.
   1. Thermally-broken clips that provide attachment support for girts, angles, channels, and other cladding support framing.

2. Fasteners: As recommended by clip manufacturer.

B. Exposed Sealants: Elastomeric; silicone, polyurethane, or silyl-terminated polyether/polyurethane.

PART 3 EXECUTION

3.01 EXAMINATION

3.02 INSTALLATION

A. Install panel system on walls and soffits in accordance with manufacturer's instructions.

B. Permanently fasten panel system to structural supports; aligned, level, and plumb, within specified tolerances.

C. Locate panel joints over supports.

D. Use concealed fasteners unless otherwise approved by Architect.

E. Seal and place gaskets to prevent weather penetration. Maintain neat appearance.

3.03 CLEANING

A. See Section 017000 - Execution and Closeout Requirements for additional requirements.

B. Remove site cuttings from finish surfaces.

3.04 PROTECTION

A. Protect installed products from damage until Date of Substantial Completion.

END OF SECTION

SECTION 095100
ACOUSTICAL CEILINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Suspended metal grid ceiling system.

B. Acoustical units.

1.02 REFERENCE STANDARDS

A. ASTM C635/C635M - Standard Specification for Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings; 2022.

B. ASTM C636/C636M - Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels; 2019.

C. ASTM E580/E580M - Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions; 2024a.

D. ASTM E1264 - Standard Classification for Acoustical Ceiling Products; 2023.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Sequence work to ensure acoustical ceilings are not installed until building is enclosed, sufficient heat is provided, dust generating activities have terminated, and overhead work is completed, tested, and approved.

B. Do not install acoustical units until after interior wet work is dry.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data on suspension system components and acoustical units.

C. Samples: Submit two samples 6 by 6 inch (____by____ mm) in size illustrating material and finish of acoustical units.

D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 016000 - Product Requirements, for additional provisions.
   2. Extra Acoustical Units: Quantity equal to 5 percent of total installed.

1.05 FIELD CONDITIONS

A. Maintain uniform temperature of minimum 60 degrees F (16 degrees C), and maximum humidity of 40 percent prior to, during, and after acoustical unit installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Suspension Systems:
   1. Same as for acoustical units.

2.02 ACOUSTICAL UNITS

A. Acoustical Panels, Type ACT-1: Painted mineral fiber, with the following characteristics:
   1. Classification: ASTM E1264 Type III.
   2. Size: 24 by 48 inches (610 by 1219 mm).
   3. Thickness: 3/4 inch (19 mm).
   4. Panel Edge: Square.
   5. Color: White.
   6. Suspension System: Exposed grid.
   7. Products:
      a. Armstrong World Industries, Inc; Fine Fissured: www.armstrongceilings.com/#sle.

B. Acoustical Panels, Type ACT-2: Painted mineral fiber, with the following characteristics:
   1. Classification: ASTM E1264 Type III.
   2. Size: 24 by 24 inches (610 by 1219 mm).
   3. Thickness: 3/4 inch (19 mm).
   4. Panel Edge: Square.
   5. Color: White.
   6. Suspension System: Exposed grid.
   7. Products:
      a. Armstrong World Industries, Inc; Fine Fissured: www.armstrongceilings.com/#sle.

2.03 SUSPENSION SYSTEM(S)

A. Metal Suspension Systems - General: Complying with ASTM C635/C635M; die cut and interlocking components, with perimeter moldings, hold down clips, stabilizer bars, clips, and splices as required.

B. Exposed Suspension System, Type ____: Hot-dip galvanized steel grid and cap.
   1. Structural Classification: Heavy-duty, when tested in accordance with ASTM C635/C635M.
   2. Profile: Tee; 15/16 inch (____ mm) face width.
   3. Finish: Baked enamel.
   4. Color: White.
   5. Products:
      a. Armstrong World Industries, Inc.; Prelude: www.armstrongceilings.com.
      b. Substitutions: See Section 016000 - Product Requirements.

2.04 ACCESSORIES

A. Support Channels and Hangers: Galvanized steel; size and type to suit application, seismic requirements, and ceiling system flatness requirement specified.

B. Hanger Wire: 12 gauge, 0.08 inch (2 mm) galvanized steel wire.

C. Perimeter Moldings: Same metal and finish as grid.

D. Touch-up Paint: Type and color to match acoustical and grid units.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that layout of hangers will not interfere with other work.

3.02 PREPARATION

A. Install after major above-ceiling work is complete.

B. Coordinate the location of hangers with other work.

C. Provide hanger clips during steel deck erection. Provide additional hangers and inserts as required.

3.03 INSTALLATION - SUSPENSION SYSTEM

A. Install suspension system in accordance with ASTM C636/C636M, ASTM E580/E580M, and manufacturer's instructions and as supplemented in this section.

B. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:360.

C. Perimeter Molding: Install at intersection of ceiling and vertical surfaces and at junctions with other interruptions.
   1. Use longest practical lengths.

D. Suspension System, Non-Seismic: Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.

E. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.

F. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.

G. Support fixture loads using supplementary hangers located within 6 inches (152 mm) of each corner, or support components independently.

H. Do not eccentrically load system or induce rotation of runners.

3.04 INSTALLATION - ACOUSTICAL UNITS

A. Install acoustical units in accordance with manufacturer's instructions.

B. Fit acoustical units in place, free from damaged edges or other defects detrimental to appearance and function.

C. Fit border trim neatly against abutting surfaces.

D. Install acoustical units level, in uniform plane, and free from twist, warp, and dents.

E. Cutting Acoustical Units:
   1. Cut to fit irregular grid and perimeter edge trim.
   2. Make field cut edges of same profile as factory edges.
   3. Double cut and field paint exposed reveal edges.

3.05 TOLERANCES

A. Maximum Variation from Flat and Level Surface: 1/8 inch in 10 feet (3 mm in 3 m).

B. Maximum Variation from Plumb of Grid Members Caused by Eccentric Loads: 2 degrees.

END OF SECTION

SECTION 230900

INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Products Furnished But Not Installed Under This Section.

B. Products Installed But Not Furnished Under This Section.

C. Related Sections.

D. Description.

E. Approved Control System Contractor.

F. Quality Assurance.

G. System Performance.

H. Submittals.

I. Warranty.

J. Ownership of Proprietary Material.

1.2 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Section 232113 - Hydronic Piping:

1. Control Valves
2. Temperature Sensor Wells and Sockets

B. Section 232300 - Refrigerant Piping:

1. Pressure and Temperature Sensor Wells and Sockets

C. Section 233300 - Duct Accessories:

1. Automatic Dampers
2. Air-flow Stations
3. Terminal Unit Controls

1.3 RELATED SECTIONS

A. The General Conditions of the Contract, Supplementary Conditions, and General Requirements are a part of these Specifications and shall be used in conjunction with this Section as a part of

the Contract Documents. Consult them for further instructions pertaining to this work. The Contractor is bound by the provisions of other Divisions.

B. Refer to other Division 23 Sections for related work.

1.4 DESCRIPTION

A. General: The control system shall be as indicated on the drawings and described in the specifications.

B. Direct Digital Control (DDC) technology shall be used to provide the functions necessary for control of mechanical systems on this project.

C. The control system shall accommodate simultaneous multiple user operation. Access to the control system data should be limited only by operator password. Multiple users shall have access to all valid system data. An operator shall be able to log onto any work-station on the control system and have access to all appropriate data.

D. The control system shall be designed such that each mechanical system will be able to operate under stand-alone control. As such, in the event of a network communication failure, or the loss of any other controller, the control system shall continue to independently operate under control.

E. Communication between the control panels and all work-stations shall be over a high speed network. All nodes on this network shall be peers. The operator shall not have to know the panel identifier or location to view or control an object. Application Specific Controllers shall be constantly scanned by the network controllers to update point information and alarm information.

F. The documentation is schematic in nature. The Contractor shall provide hardware and software necessary to implement the functions and sequences shown and operate the systems in a safe and stable manner.

1.5 QUALITY ASSURANCE

A. System Installer Qualifications

1. The Installer shall have an established working relationship with the Control System Manufacturer of not less than three years.
2. The Installer shall have successfully completed Control System Manufacturer's classes on the control system and have a minimum of five years experience in the design and installation of control systems. The Installer shall present for review the certification of completed training, including the hours of instruction and course outlines upon request.
3. The installer shall have an office within 75 miles of the project site and provide 24 hour response in the event of a customer call.

    a. The contractor shall employ technicians to provide instruction, routine maintenance, and emergency service within 24 hours upon receipt of request.

B. System Integrator Qualifications

1. Owner Approved System Integrator Contractors include the following:

a. JB electric
b. W. J. O'Neil
c. Control Net, West office

2. The system integrator must be regularly engaged in the service and installation of Lonworks based systems as specified herein, and must have been so for a minimum of three (3) years.
3. The system integrator must be an authorized representative in good standing of the manufacturer of the proposed hardware and software components, and must have been so for a minimum of three (3) years.
4. The system integrator shall have an office that is staffed with designers trained in integrating interoperable systems and technicians fully capable of providing Lonworks instruction and routine emergency maintenance service on all system components.
5. The system integrator shall have in house capabilities to provide control strategies for whole building control. This includes HVAC, lighting, access, and security applications.
6. The system integrator shall have a service facility, staffed with qualified service personnel, capable of providing instructions and routine emergency maintenance service for networked control systems.
7. The system integrator shall Submit a list of no less than three (3) similar projects, which have Lonworks based Building Systems as specified herein installed by the system integrator These projects must be on-line and functional such that the Owners/Users representative can observe the system in full operation.
8. The system integrator must be a certified Lonworks Integrator, or submit resumes with the proposal indicating passing certificates for Echelon Corporation's approved interoperable, or proof of equivalent training. Such proof must include summary of coursework and indicate both written and laboratory requirements of alternate training.
9. Installer must be Echelon certified in order to terminate devices and panels. If not certified, then installer can only run conduit and pull wire.

C. Hardware and Software Component Manufacturer Qualification

1. Owner Approved Manufacturers of hardware and software components include the following:
   a. Circon EBS Systems

2. The manufacturer of the hardware and software components must be primarily engaged in the manufacture of Lonworks based systems as specified herein, and must have been so for a minimum of three (7) years.
3. The manufacturer of the hardware and software components as well as its subsidiaries must be a member in good standing of the LonMark Organization.
4. The manufacturer of the hardware and software components shall have an authorized representative capable of providing service and support as referenced in section B above, and must have done so for a minimum of three (3) years.
5. The manufacturer of the hardware and software components shall have a technical support group accessible via a toll free number that is staffed with qualified personnel, capable of providing instruction and technical support service for networked control systems.
6. The manufacturer of the hardware and software components must be authorized to certify Lonworks Integrators as defined by Echelon Corporation. They also must provide for Echelon Corporation's approved Lonworks curriculum.
7. The manufacturer of the hardware and software components must have no less than three (3) similar projects, which have Lonworks based building systems as specified herein installed by the authorized representative referenced above. These projects must

be on-line and functional such that the Owners/Users representative can observe the system in full operation.

D. Products

1. Utilize standard PC components for all assemblies. Custom hardware, operating system, and utility software are not acceptable.
2. All products (PROGRAMMABLE CONTROLLER's, TDCU's and ID's) shall contain ANSI EIA 709.1 LonTalk Protocol networking elements to allow ease of integration of devices from multiple vendors.
3. All materials, equipment and software shall be standard components, regularly manufactured for this and other sstems and custom designed for this project. All systems and components shall be thoroughly tested.

E. Codes and Standards: Meet requirements of all applicable standards and codes, except when more detailed or stringent requirements are indicated by the Contract Documents, including requirements of this Section.

1. Underwriters Laboratories: Products shall be UL-916-PAZX listed.
2. National Electrical Code -- NFPA 70.
3. Federal Communications Commission -- Part J.
4. ASHRAE/ ANSI EIA 709.1 LonTalk Protocol.
5. LonMark certified, and LNS Based.

F. All products used in this installation shall be new, currently under manufacture, and shall be applied in similar installations for a minimum of 2 years. This installation shall not be used as a test site for any new products unless explicitly approved by the Owner's representative in writing prior to bid date. Spare parts shall be available for at least 5 years after completion of this contract.

1.6 SYSTEM PERFORMANCE

A. Performance Standards. The system shall conform to the following:

1. Graphic Display. The system shall display a graphic with a minimum of 20 dynamic points. All current data shall be displayed within 20 seconds of the request.
2. Graphic Refresh. The system shall update all dynamic points with current data within 30 seconds.
3. Object Command. The maximum time between the command of a binary object by the operator and the reaction by the device shall be 10 seconds. Analog objects shall start to adjust within 10 seconds.
4. Object Scan. All changes of state and change of analog values shall be transmitted over the high-speed network such that any data used or displayed at a controller or work-station will be current, within the prior 60 seconds.
5. Alarm Response Time. The maximum time from when an object goes into alarm to when it is annunciated at the work-station shall not exceed 45 seconds.
6. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 seconds. The Contractor shall be responsible for selecting execution times consistent with the mechanical process under control.
7. Performance. Programmable Controllers shall be able to execute DDC PID control loops at a selectable frequency from at least once every 5 seconds. The controller shall scan and update the process value and output generated by this calculation at this same frequency.

8. Multiple Alarm Annunciation. All work-stations on the network shall receive alarms within 5 seconds of each other.
9. Reporting Accuracy. Table 1 lists minimum acceptable reporting accuracies for all values reported by the specified system.

a. Table 1 -- Reporting Accuracy

Measured Variable	Reported Accuracy
Space temperature	±0.5°C (±1°F)
Ducted air	±1.0°C (±2°F)
Outside air	±1.0°C (±2°F)
Water temperature	±0.5°C (±1°F)
Delta-T	±0.15°C (±0.25°F)
Relative humidity	±5% RH
Water flow	±5% of full scale
Air flow (terminal)	±10% of reading *Note 1
Air flow (measuring stations)	±5% of reading
Air pressure (ducts)	±25 Pa (±0.1 "W.G.)
Air pressure (space)	±3 Pa (±0.01 "W.G.)
Water pressure	±2% of full scale *Note 2
Electrical Power	5% of reading *Note 3
Carbon Monoxide (CO)	± 50 PPM
Carbon Dioxide (CO2)	± 50 PPM

Note 1: (10%-100% of scale) (cannot read accurately below 10%)
Note 2: for both absolute and differential pressure
Note 3: * not including utility supplied meters

1.7 SUBMITTALS

A. Controls Schedule of Values

1. Contractor shall provide a schedule of values with the following categories.
   a. Shop drawings/Control drawings/State of Michigan Permit.
   b. Engineering/programming and graphics.
      1) In order to receive payment for engineering, contractor must turn over LNS database to prove engineering work has been performed.
   c. DDC Materials.
   d. DDC Installation.
   e. Commissioning.
   f. Punchlist completion/Closeout.

B. Contractor shall provide shop drawings and manufacturers' standard specification data sheets on all hardware and software to be provided. No work may begin on any segment of this project until submittals have been reviewed by the Engineer and Owner for conformity with the plan and specifications. All shop drawings shall be done on computer aided design software and provided to the Engineer/Owner via email as PDF. Shop drawings shall include the following:

1. Schematic flow diagrams.
2. Power, signal, and control wiring diagrams.
3. Details of control panel faces.
4. Damper schedule.
5. Valve schedule.

6. DDC System Hardware: Wiring diagrams, schematic floor plans, and schematic control diagrams.
7. Physical location of all control cabinets based on room number.

C. Quantities of items submitted shall be reviewed by the Engineer and Owner. Such review shall not relieve the contractor from furnishing quantities and specified functionality required for completion.

D. Provide the Engineer and Owner, any additional information or data which is deemed necessary to determine compliance with these specifications or which is deemed valuable in documenting the system to be installed.

E. Submit the following within 60 days of contract award:

1. A complete bill of materials of equipment to be used indicating quantity, manufacturer and model number.
2. A schedule of all control valves including the valve size, model number (including pattern and connections), flow, CV, pressure rating, and location.
3. A schedule of all control dampers. This shall include the damper size, pressure drop, manufacturer and model number.
4. Provide manufacturers cut sheets for major system components. When manufacturer's cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawings shall clearly reference the specification and/or drawing that the submittal is being submitted to cover. Include:

    a. Building Controllers
    b. Custom Application Controllers
    c. Application Specific Controllers
    d. Operator Interface Computer
    e. Portable Operator Workstation
    f. Auxiliary Control Devices
    g. Proposed control system riser diagram showing system configuration, device locations, addresses, and cabling.
    h. Detailed termination drawings showing all required field and factory terminations. Terminal numbers shall be clearly labeled.
    i. Points list showing all system objects and the proposed English language object names.
    j. Sequence of operations for each system under control. This sequence shall be specific for the use of the Control System being provided for this project.
    k. Provide a LonTalk Product Implementation Conformance Statement (PICS) for each LonTalk device type in the submittal.
    l. Color prints of proposed graphics with a list of points for display.

F. Project Record Documents: Upon completion of installation submit three (3) copies of record (as-built) documents. The documents shall be submitted for approval prior to final completion and include:

1. Project Record Drawings - These shall be as-built versions of the submittal shop drawings. One set of magnetic media including computer aided desing drawing files shall also be provided.
2. Testing and Commissioning Reports and Checklists.
3. Operating and Maintenance (O & M) Manual - These shall be as-built versions of the submittal product data. In addition to that required for the submittals, the O & M manual shall include:

a. Names, address and 24-hour telephone numbers of Contractors installing equipment, and the control systems and service representative of each.
b. Operators Manual with procedures of operating the control systems including logging on/off, alarm handling, producing point reports, trending data, overriding computer control, and changing set points and other variables.
c. Programming Manual with a description of the programming language including syntax, statement descriptions including algorithms and calculations used, point database creation and modification, program creation and modification, and use of the editor.
d. Licenses, Guarantee, and Warrantee documents for all equipment and systems.

1.8 WARRANTY

A. Warrant all work as follows:

1. Labor & materials for control system specified shall be warranted free from defects for a period of eighteen (18) months after final completion acceptance by the Owner. Control System failures during the warranty period shall be adjusted, repaired, or replaced at no charge or reduction in service to the Owner. The warranty shall extend to material that is supplied and installed by the Contractor. Material supplied but not installed by the Contractor shall be covered per the above to the extent of the product only. Installation labor shall be the responsibility of the trade contractor performing the installation. The Contractor shall respond to the Owner's request for warranty service within 24 hours during customary business hours.
2. Service shall be provided within 4 hours upon notice from Owner’s designated Representative.
3. At the end of the final start-up/testing, if equipment and systems are operating satisfactorily to the Owner and Engineer, the Owner shall sign certificates certifying that the control system's operation has been tested and accepted in accordance with the terms of this specification. The date of Owner's acceptance shall be the start of warranty.
4. Operator work-station software, project specific software, graphics, database, and firmware updates shall be provided to the Owner at no charge during the warranty period. Written authorization by Owner must, however, be granted prior to the installation of such changes.

1.9 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Do not install electronic hardware in the project until non-condensing environmental conditions have been established. Products installed in violation of this request maybe requested to be replaced at no additional cost to the project.

B. Coordinate storage requirements for factory mounted terminal control units on air terminal devices, air handling units or other packaged control equipment. Do not store control units on site in non-conditioned areas for more than two weeks.

C. Factory-Mounted Components: Where control devices specified in this section are indicated to be factory mounted on equipment, arrange for shipping control devices to unit manufacturer.

1.10 OWNERSHIP OF PROPRIETARY MATERIAL

A. All project developed hardware and software shall become the property of the Owner. These include but are not limited to:

1. Project graphic images,
2. Record drawings,
3. Project database,
4. Job-specific application programming code,
5. All documentation.

PART 2 - PRODUCTS

2.1 SECTION INCLUDES

A. Acceptable Manufacturers.

B. Operator Interface.

C. System Software.

D. Building Controllers.

E. Custom Application Controllers.

F. Application Specific Controllers.

G. Communications.

H. Input/Output Interface.

I. Auxiliary Control Devices.

2.1 PRODUCTS GENERAL

A. All products (PROGRAMMABLE CONTROLLER's, TDCU's and ID's) shall contain ANSI EIA 709.1 LonTalk Protocol networking elements to allow ease of integration of devices from multiple vendors.

B. All materials, equipment and software shall be standard components, regularly manufactured for this and other systems and custom designed for this project. All systems and components shall be thoroughly tested.

C. Control system components shall be new and in conformance with the following applicable standards for products specified:
1. LonMark certified, and LNS Based.
2. ANSI EIA 709.1 LonTalk Protocol.

D. Utilize standard PC components for all assemblies. Custom hardware, operating system, and utility software are not acceptable.

E. All products (PROGRAMMABLE CONTROLLER's, TDCU's and ID's) shall contain ANSI EIA 709.1 LonTalk Protocol networking elements to allow ease of integration of devices from multiple vendors.

F. All materials, equipment and software shall be standard components, regularly manufactured for this and other systems and custom designed for this project. All systems and components shall be thoroughly tested.

2.2 **PROGRAMMING CONTROL UNIT AND PROGRAMMING SOFTWARE**

A. Refer to drawings for normal operating mode sequences of operations.

B. General.
1. Provide automatic control for system operation as described herein, although word "automatic" or "automatically", is not used.
2. Provide control devices, control software and control wiring as required for automatic operation of each sequence specified.
3. Manual operation is limited only where specifically described; however, provide manual override for each automatic operation.
4. Where manual start-up is called for, also provide scheduled automatic start-stop capabilities.
5. Functions called for in sequence of operations are minimum requirements and not to limit additional capabilities the DDC system can be provided with.
6. Provide following functions which are not specifically mentioned in each Sequence of Operation:
   a. For each item of equipment:
      (i) Start-Stop, manual, and scheduled.
      (ii) On-Off status of each piece of equipment.
      (iii) All setpoints shall be adjustable.
   b. Sequenced starting of all motors:
      (i) At initial start-up.
      (ii) For automatic starting on emergency power after power blackout.

2.2 ACCEPTABLE MANUFACTURERS

A. Base Bid: Circon EBS Systems

B. All products (PROGRAMMABLE CONTROLLER's, TDCU's and ID's) shall contain ANSI EIA 709.1 LonTalk Protocol networking elements to allow ease of integration of devices from multiple vendors.

C. All materials, equipment and software shall be standard components, regularly manufactured for this and other systems and custom designed for this project. All systems and components shall be thoroughly tested.

D. Control system components shall be new and in conformance with the following applicable standards for products specified:

1. LonMark certified, and LNS Based.
2. ANSI EIA 709.1 LonTalk Protocol.

E. Utilize standard PC components for all assemblies. Custom hardware, operating system, and utility software are not acceptable.

F. All products (PROGRAMMABLE CONTROLLER's, TDCU's and ID's) shall contain ANSI EIA 709.1 LonTalk Protocol networking elements to allow ease of integration of devices from multiple vendors.

G. All materials, equipment and software shall be standard components, regularly manufactured for this and other systems and custom designed for this project. All systems and components shall be thoroughly tested.

2.3 OPERATOR INTERFACE

A. Operator Interface. Furnish 1 PC based work-station. The work-station shall be able to access all information in the system. The work-station shall reside on the same high speed network as the building controllers, and also be able to dial into the system.

B. Work-station information access shall use the LonTalk Protocol. Communication shall use the ISO 8802-3 (Ethernet) or ARCNET (ASTM 878.1) Physical/Data Link layer protocol. Remote communications shall use the LonTalk Point to Point Physical/Data Link Layer Protocol.

C. Hardware. Each operator work-station shall consist of the following:

1. Personal Computer. The Operators Workstation shall be Laptop.
   a. Basis of Design: Subject to compliance with requirements provide: Dell Latitude 5550 laptap or approved equal.

      1) Operating System - Windows 11 pro.
      2) 64 bit.
      3) 16 GB DDR5 RAM.
      4) 256 GB SSD.
      5) Screen Size -15" or larger.
      6) (2) USB interface ports for connection capable of connecting with Controller by owner.
      7) (2) USB-C interface ports.
      8) Ethernet port.
      9) Ultra-7 processor or above.
      10) All software required for system operation and system programming shall be installed on laptop for owner.
      11) Coordinate software requirements with DMVA control technicians

2. Modems. Furnish auto-dial telephone modems and associated cables as required for communication to remote buildings, and work stations. The modem shall transmit at a minimum of 14400 baud, and communicate over voice-grade telephone lines.
3. Printers. Each work station shall have 1 printer, with tractor feed, and associated cables. Each printer shall be capable of a minimum 160 characters per second operation and be compatible with standard parallel or serial communications. Supply one box of minimum 2000 sheets of printer paper and two (2) printer ribbons or cartridges.
4. LonTalk. The PCWS shall use the Read (Initiate) and Write (Execute) Services as defined in Clauses 15.5 and 15.8, respectively, of ASHRAE Standard 135-95, to communicate with LonTalk objects in the internetwork. Objects supported shall include: Analog input, analog output, analog value, binary input, binary output, binary value, device.

D. System Software

1. Operating System. Furnish a commercially available, concurrent multi-tasking operating system. The operating system shall also support the use of other common software applications that operate under DOS or Microsoft Windows. Acceptable operating systems are Windows NT, and Windows 95/98.
2. System Graphics. The Operator Work-station software shall be graphically oriented. The system shall allow display of up to 10 graphic screens at once for comparison and monitoring of system status. Provide a method for the operator to easily move between graphic displays and change the size and location of graphic displays on the screen. The system graphics shall be able to be modified while on line. An operator with the proper password level shall be able to add, delete, or change dynamic points on a graphic. Dynamic points shall include analog and binary values, dynamic text, static text, and animation files. Graphics shall have the ability to show animation of equipment.

    a. Custom Graphics. Custom graphic files shall be created with the use of commonly available graphics packages such as PC Paint. The graphics generation package shall create and modify graphics that are saved in industry standard formats such as PCX, BMP, GIF and JPEG. The graphics generation package shall also provide the capability of capturing or converting graphics from other programs such as Designer, or AutoCAD.
    b. Graphics Library. Furnish a complete library of standard HVAC equipment such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators. This library shall also include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and duct-work. The library shall be furnished in a file format compatible with the graphics generation package program.
    c. Engineering Units. Allow for selection of the desired engineering units (i.e. Inch pound or SI) in the system. Unit selection shall be able to be customized by locality to select the desired units for each measurement. Engineering units on this project shall be: Standard Inch Pound.

E. System Applications. Each work-station shall provide operator interface and off-line storage of system information. Provide the following applications at each work-station.

1. Automatic System Database Save and Restore. Each work-station shall store on the hard disk a copy of the current database of each building controller. This database shall be updated whenever a change is made in any panel in the system. The storage of this data shall be automatic and not require operator intervention. In the event of a database loss in a building management panel, the first work-station to detect the loss shall automatically restore the database for that panel.
2. Manual Database Save and Restore. A system operator with the proper password clearance shall be able to archive the database from any system panel and store on magnetic media. The operator shall also be able to clear a panel database and manually initiate a download of a specified database to any panel in the system.
3. System Configuration. The work-station software shall provide a graphical method of configuring the system. The user with proper security shall be able to add new devices, and assign modems to devices. This shall allow for future system changes or additions.
4. On-Line Help. Provide a context sensitive, on line help system to assist the operator in operation and editing of the system. On line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext.
5. Security. Each operator shall be required to log on to the system with a user name and password in order to view, edit, add, or delete data. System security shall be selectable for each operator. The system supervisor shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict

the operators access for viewing and/or changing each system application, full screen editor, and object. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected. This auto logoff time shall be set per operator password. All system security data shall be stored in an encrypted format.

6. System Diagnostics. The system shall automatically monitor the operation of all work-stations, printers, modems, network connections, building management panels, and controllers. The failure of any device shall be annunciated to the operator.
7. Alarm Processing. Any object in the system shall be configurable to alarm in and out of normal state. The operator shall be able to configure the alarm limits, warning limits, states, and reactions for each object in the system.

    a. Alarm Reactions. The operator shall be able to determine what actions, if any, are to be taken, by object (or point), during an alarm. Actions shall include logging, printing, starting programs, displaying messages, dialing out to remote stations, paging, providing audible annunciation or displaying specific system graphics. Each of these actions shall be configurable by work-station and time of day. An object in alarm that has not been acknowledged within an operator specified time period shall be re-routed to an alternate operator specified alarm receipt device.
    b. Binary Alarms. Each binary object shall be set to alarm based on the operator specified state. Provide the capability to disable alarming when the associated equipment is turned off or is being serviced.
    c. Analog Alarms. Each analog object shall have both high and low alarm limits and warning limits. Alarming must be able to be automatically and manually disabled.

8. Trend Logs. The operator shall be able to define a custom trend log for any data in the system. This definition shall include interval, start-time, and stop-time. Trend intervals of 1, 5, 15, 30, and 60 minutes as well as once a shift (8 hours), once a day, once a week, and once a month shall be selectable. All trends shall start based on the hour. Each trend shall accommodate up to 64 system objects. The system operator with proper password shall be able to determine how many samples are stored in each trend. Trend data shall be sampled and stored on the Building Controller panel and be archived on the hard disk. Trend data shall be able to be viewed and printed from the operator interface software. Trends must be viewable in a text based format or graphically. They shall also be storable in a tab delimited ASCII format for use by other industry standard word processing and spreadsheet packages.
9. Dynamic Graphical Charting. The operator shall be able to select system values to be charted in real time. Up to three values at one time can be selected for each chart. The type of chart (bar, line, 3-D, etc.) shall be selectable.
10. Alarm and Event Log. The operator shall be able to view all logged system alarms and events from any location in the system. Events shall be listed chronologically. An operator with the proper security level may acknowledged and clear alarms. All that have not been cleared by the operator shall be archived to the hard disk on the work-station.
11. Object and Property Status and Control. Provide a method for the operator with proper password protection to view, and edit if applicable, the status of any object and property in the system. These statuses shall be available by menu, on graphics, or through custom programs.
12. Clock Synchronization. The real time clocks in all building control panels and work-stations shall be synchronized on command of an operator. The system shall also be able to automatically synchronize all system clocks, daily from any operator designated device in the system. The system shall automatically adjust for daylight savings and standard time if applicable.
13. Reports and Logs. Provide a reporting package that allows the operator to select, modify, or create reports. Each report shall be definable as to data content, format, interval, and date. Report data shall be archived on the hard disk for historical reporting. Provide the ability for the operator to obtain real time logs of designated lists of objects.

Reports and logs shall be stored on the PC hard disk in a format that is readily accessible by other standard software applications including spreadsheets and word processing. Reports and logs shall be readily printed to the system printer. The operator shall be able to designate reports that shall be printed or stored to disk at selectable intervals.

a. Custom Reports: Provide the capability for the operator to easily define any system data into a daily, weekly, monthly, or annual report. These reports shall be time and date stamped and shall contain a report title and the name of the facility.
b. Standard Reports. The following standard system reports shall be provided for this project. These reports shall be readily customized to the project by the owner.

14. Electrical Meter Report: Provide a monthly report showing the daily electrical consumption and peak electrical demand for each building meter. Provide an annual (12 month) summary report showing the monthly electrical consumption and peak demand for each meter. Include 12 meters.
15. Weather Data Report: Provide a monthly report showing the daily minimum, maximum and average outdoor air temperature and the number of heating and cooling degree days for each day. Provide an annual (12 month) report showing the minimum, maximum and average outdoor air temperature for the month and the number of heating and cooling degree days for the month.
16. Tenant Override Reports: Provide a monthly report showing the daily total time in hours that each tenant has requested after hours HVAC and lighting services. Provide an annual summary report that shows the override usage on a monthly basis.

F. Work-station Applications Editors. Each PC work-station shall support full screen editing of all system applications. Provide editors for each application at the PC work-station. The applications shall be downloaded and executed at the appropriate controller panels.

1. Controller. Provide a full screen editor for each type controller and application, that shall allow the operator with proper password to view and change the configuration, name, control parameters, and system set-points.
2. Scheduling. An editor for the scheduling application shall be provided at each work-station. Provide a monthly calendar for each schedule. Exception schedules and holidays shall be shown clearly on the calendar. Provide a method for allowing several related objects to follow a schedule. The advance and delay time for each object shall be adjustable from this master schedule.

    a. An operator with proper password level shall be able to modify the schedule. Schedules shall be able to be easily copied between objects and/or dates.

3. Equipment Coordination. Provide a full screen editor that allows equipment to be grouped for proper operation as specified in the sequence of operations. This shall include the coordination of VAV boxes with their associated Air Handling Equipment.

4. Custom Application Programming. Provide the tools to create, modify, and debug custom application programming. The operator shall be able to create, edit, and download custom programs at the same time that all other system applications are operating. The system shall be fully operable while custom routines are edited, compiled, and downloaded. The programming language shall have the following features:

    a. The language shall be English language oriented and be based on the syntax of programming languages such as BASIC. It shall allow for free form or fill in the blank programming. Alternatively, the programming language can be graphically-based using function blocks as long as blocks are available that directly provide

the functions listed below, and that custom or compound function blocks can be created.

b. A full screen character editor/programming environment shall be provided. The editor shall be cursor/mouse-driven and allow the user to insert, add, modify, and delete code from the custom programming. It shall also incorporate word processing features such as cut/paste and find/replace.

c. The programming language shall allow independently executing program modules to be developed. Each module shall be able to independently enable and disable other modules.

d. The editor/programming environment shall have a debugging/simulation capability that allows the user to step through the program and to observe any intermediate values and or results. The debugger shall also provide error messages for syntax and execution errors.

e. The programming language shall support conditional statements (IF/THEN/ELSE/ELSE-IF) using compound Boolean (AND, OR, and NOT) and/or relations (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.

f. The programming language shall support floating point arithmetic using the following operators: +, -, /, x, square root, and xy. The following mathematical functions shall also be provided: natural log, log, absolute value, and minimum/maximum value from a list of values.

g. The programming language shall have pre-defined variables that represent clock time, day of the week, and date. Variables that provide interval timing shall also be available. The language shall allow for computations using these values.

h. The programming language shall have ability to pre-defined variables representing the status and results of the System Software, and shall be able to enable, disable, and change the values of LonTalk objects in the system.

G. Portable Operator's Terminal. Furnish a Portable Operator's Terminal that shall be capable of accessing all system data. This device may be connected to any point on the system inter-network or may be connected directly to any controller for programming, set-up, and troubleshooting LonTalk. The Portable Operators Terminal shall use the Read (Initiate) and Write (Execute) Services as defined in Clauses 15.5 and 15.8, respectively, of ASHRAE Standard 135-95, to communicate with LonTalk objects in the internetwork. Objects supported shall include: Analog input, analog output, analog value, binary input, binary output, binary value, device.

1. The Portable Operator's Terminal shall be an IBM compatible notebook-style PC including all software and hardware required. The PC shall contain at minimum:

c. Operating System - Windows 11 pro.
d. 64 bit.
e. 16 GB DDR5 RAM.
f. 256 GB SSD
g. Screen Size -15” or larger.
h. (2) USB interface ports for connection capable of connecting with Controller by owner.
i. (2) USB-C interface ports.
j. Ethernet port.
k. Ultra-7 processor or above.
l. All software required for system operation and system programming shall be installed on laptop for owner.
m. Coordinate software requirements with DMVA control technicians.

2.4 SYSTEM SOFTWARE

A. Furnish the following applications software for building and energy management. All software applications shall reside and run in the system controllers. Editing of applications shall occur at the operator work-station.

B. System Security

1. User access shall be secured using individual security passwords and user names.
2. Passwords shall restrict the user to only the objects, applications, and system functions as assigned by the system manager.
3. User logon/logoff attempts shall be recorded.
4. The system shall protect itself from unauthorized use by automatically logging off following the last keystroke. The delay time shall be user definable.

C. Scheduling. Provide the capability to schedule each object or group of objects in the system. Each of these schedules shall include the capability for start, stop, optimal start, optimal stop, and night economizer actions. Each schedule may consist of up to 10 events. When a group of objects are scheduled together, provide the capability to define advances and delays for each member. Each schedule shall consist of the following:

1. Weekly Schedule. Provide separate schedules for each day of the week.
2. Exception Schedules. Provide the ability for the operator to designate any day of the year as an exception schedule. This exception schedule shall override the standard schedule for that day. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed it will be discarded and replaced by the standard schedule for that day of the week.
3. Holiday Schedules. Provide the capability for the operator to define up to 99 special or holiday schedules. These schedules may be placed on the scheduling calendar and will be repeated each year. The operator shall be able to define the length of each holiday period.
4. Optimal Start/Stop. The scheduling application outlined above shall support an optimal start/stop algorithm. This shall calculate the thermal characteristics of a zone and start the equipment prior to occupancy to achieve the desired space temperature at the specified occupancy time. The algorithm shall calculate separate sets of heating and cooling rates for zones that have been unoccupied for less then and greater than 24 hours. Provide the ability to modify the start/stop algorithm based on outdoor air temperature. Provide an early start limit in minutes to prevent the system from starting before an operator determined time limit.

D. Alarm Reporting. The operator shall be able to determine the action to be taken in the event of an alarm. Alarms shall be routed to the appropriate work-stations based on time and other conditions. An alarm shall be able to start programs, be logged in the event log, printed, generate custom messages graphics.

E. Remote Communications. The system shall have the ability to dial out in the event of an alarm. Receivers shall include PC Workstations, and Alpha-numeric pagers. The alarm message shall include the name of the calling location, the device that generated the alarm, and the alarm message itself. The operator shall be ably to remotely access and operate the system using dial up communications in the same format and method used on site under section 2.1 (Operator Interface).

F. Demand Limiting.

1. The demand limiting program shall monitor building power consumption from signals generated by a pulse generator (provided by others) mounted at the building power meter, or from a watt transducer or current transformer attached to the building feeder lines.
2. The demand limiting program shall be based on a predictive sliding window algorithm. The sliding window duration and sampling interval shall be set equal to that of the local Electrical Utility.
3. Control system shall be capable of demand limiting by resetting HVAC system set-points to reduce load while maintaining Indoor Air Quality (humidity, VOC, CO2) and comfort control in the space.
4. Input capability shall also be provided for an end-of-billing period indication.

G. Maintenance Management. The system shall monitor equipment status and generate maintenance messages based upon user designated run time, starts, and/or calendar date limits.

H. PID Control. A PID (proportional-integral-derivative) algorithm with direct or reverse action and anti-wind-up shall be supplied. The algorithm shall calculate a time-varying analog value used to position an output or stage a series of outputs. The controlled variable, set-point, and PID gains shall be user-selectable. The set-point shall optionally be chosen to be a reset schedule.

I. Staggered Start. This application shall prevent all controlled equipment from simultaneously restarting after a power outage. The order in which equipment (or groups of equipment) is started, along with the time delay between starts shall be user-selectable.

J. System Calculations. Provide software to allow instantaneous power (e.g. KW), flow rates (e.g. GPM) to be accumulated and converted to energy usage data. Provide an algorithm that calculates a sliding-window KW demand value. Provide an algorithm that calculates energy usage and weather data (heating and cooling degree days). These items shall all be available for daily, previous day, monthly and the previous month.

K. Anti-Short Cycling. All binary output points shall be protected from short cycling. This feature shall allow minimum on-time and off-time to be selected.

L. Tenant Override and Billing. Provide application to allow building's tenants to request after-hours air conditioning and lighting and generate monthly invoices for after-hours usage. The tenant override and billing system shall perform the following functions:

1. Generate a monthly invoice for each tenant detailing user names, hours override occurred and billable amount for each after-hours request, total invoice amount and remittance address.
2. Print out customized system instruction sheets for each user.
3. Allow for a maximum of 8999 tenant zones.
4. Allow tenant the choice of overriding air conditioning and lights or lighting only.
5. Allow for separate hourly billing rates for each tenant zone.
6. Allow system user to customize monthly invoices.
7. Allow tenants to request after-hours usage through an automated attendant telephone interface that is available 24 hours/day, 7 days/week.
8. Allow system operator to setup standing override requests for tenants.
9. Allow system operator to schedule non-billable after-hours usage for tenants.
10. Bill tenants only for usage outside of normal operating hours which are adjustable per tenant zone.
11. Maintain historical database of after-hours system usage
12. Allow tenants to request up to a 24 hour override.

13. Allow system operator to record a custom broadcast message that would be heard by all tenants requesting overrides.

2.5 BUILDING CONTROLLERS

A. General. Provide Building Controllers to provide the performance specified in section 1 of this division. Each of these panels shall meet the following requirements.

1. The Building Automation System shall be composed of one or more independent, stand-alone, microprocessor based Building Controllers to manage the global strategies described in System software section.
2. The Building Controller shall have sufficient memory to support its operating system, database, and programming requirements.
3. The controller shall provide a communications port for connection of the Portable Operators Terminal using Point to Point LonTalk physical/data link layer protocol or a connection to the inter-network.
4. The operating system of the Controller shall manage the input and output communications signals to allow distributed controllers to share real and virtual point information and allow central monitoring and alarms.
5. Controllers that perform scheduling shall have a real time clock.
6. Data shall be shared between networked Building Controllers.
7. The Building Controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall:

    a. Assume a predetermined failure mode.
    b. Generate an alarm notification.

8. LonTalk. The Building Controller shall use the Read (Initiate) and Write (Execute) Services as defined in Clauses 15.5 and 15.8, respectively, of ASHRAE Standard 135-95, to communicate with LonTalk objects in the internetwork. Objects supported shall include: Analog input, analog output, binary input, binary output, device.

B. Communications. Each Building Controller shall reside on a LonTalk inter-network using the ISO 8802-3 (Ethernet) or ARCNET (ASTM 878.1) Physical/Data Link layer protocol. Each Building Controller shall also perform routing to a network of Custom Application and Application Specific Controllers.

C. Environment. Controller hardware shall be suitable for the anticipated ambient conditions. Controller used in conditioned ambient shall be mounted in an enclosure, and shall be rated for operation at 0 C to 50 C (32 F to 120 F).

D. Serviceability. Provide diagnostic LEDs for power, communications, and processor. All wiring connections shall be made to field removable, modular terminal strips or to a termination card connected by a ribbon cable.

E. Memory. The Building Controller shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.

F. Immunity to power and noise. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shut-down below 80% nominal voltage.

G. Controllers are to be cabinet mounted only. Controllers are not permitted in any type of mechanical equipment. Cabinet locations, if not specified on drawings, must be

approved by State of Michigan. Cabinet locations, if not specified on drawings, must be approved by State of Michigan.

2.6 CUSTOM APPLICATION CONTROLLERS

A. General. Provide Custom Application Controllers to provide the performance specified in section 1 of this division. Each of these panels shall meet the following requirements.

1. The Building Automation System shall be composed of one or more independent, stand-alone, microprocessor based Building Controllers to manage the local strategies described in System software section.
2. The Controller shall have sufficient memory to support its operating system, database, and programming requirements.
3. Controllers that perform scheduling shall have a real time clock.
4. The operating system of the Controller shall manage the input and output communications signals to allow distributed controllers to share real and virtual point information and allow central monitoring and alarms.
5. Data shall be shared between networked Controllers.
6. The Controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall:

    a. Assume a predetermined failure mode.
    b. Generate an alarm notification.

B. Environment. Controller hardware shall be suitable for the anticipated ambient conditions.

1. Controllers used outdoors and/or in wet ambient shall be mounted within NEMA 4 Type waterproof enclosures, and shall be rated for operation at -40 C to 65 C.
2. Controller used in conditioned ambient shall be mounted in NEMA 1 Type rated enclosures, and shall be rated for operation at 0 C to 50 C.

C. Keypad. A local keypad and display shall be provided where specified in the sequence of operations or points list. Keypad shall be provided for interrogating and editing data. An optional system security password shall be available to prevent unauthorized use of the keypad and display.

D. Serviceability. Provide diagnostic LEDs for power, communications, and processor. All wiring connections shall be made to field removable, modular terminal strips or to a termination card connected by a ribbon cable.

E. Memory. The Controller shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.

F. Immunity to power and noise. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shut-down below 80% nominal voltage.

2.7 APPLICATION SPECIFIC CONTROLLERS

A. General. Application specific controllers (ASC) are microprocessor-based DDC controllers which through hardware or firmware design are dedicated to control a specific piece of equipment. They are not fully user programmable, but are customized for operation within the confines of the equipment they are designed to serve.

1. Each ASC shall be capable of stand-alone operation and shall continue to provide control functions without being connected to the network.
2. Each ASC will contain sufficient I/O capacity to control the target system.

B. Environment. The hardware shall be suitable for the anticipated ambient conditions.

1. Controllers used outdoors and/or in wet ambient shall be mounted within NEMA 4 Type waterproof enclosures, and shall be rated for operation at -40 C to 65 C.
2. Controller used in conditioned ambient shall be mounted in NEMA 1 Type rated enclosures, and shall be rated for operation at 0 C to 50 C.

C. Serviceability. Provide diagnostic LEDs for power, and communications. All wiring connections shall be made to field removable, modular terminal strips or to a termination card connected by a ribbon cable.

D. Memory. The Application Specific Controller shall maintain all BIOS and programming information in the event of a power loss for at least 90 days.

E. Immunity to Power and noise. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shut-down below 80%.

F. Transformer. Power supply for the ASC must be rated at minimum of 125% of ASC power consumption, and shall be fused or current limiting type.

2.8 COMMUNICATIONS

A. This project shall comprise a LonTalk inter-network. All PC Workstations and Building Controller components shall meet ASHRAE / ANSI EIA 709.1 LonTalk Protocol.

B. Each LonTalk device shall operate on the LonTalk physical/data link protocols specified for that device as defined earlier in this section

C. The controls Contractor shall provide all communication media, connectors, repeaters, hubs, and routers necessary for the inter-network.

D. All Building Controllers shall have a communications port for connections with the operator interfaces. This may be either an RS-232 port for Point to Point connection or a network interface node for connection to the Ethernet or ARCNET network.

E. Remote operator interface via a 9600 or faster baud modem shall allow for communication with any and all controllers on this network as described in F below.

F. Communications services over the internetwork shall result in operator interface and value passing that is transparent to the internetwork architecture as follows:

1. Connection of an operator interface device to any one controller on the internetwork will allow the operator to interface with all other controllers as if that interface were directly connected to the other controllers. Data, status information, reports, system software, custom programs, etc., for all controllers shall be available for viewing and editing from any one controller on the internetwork.
2. All database values (i.e., points, software variable, custom program variables) of any one controller shall be readable by any other controller on the internetwork. This value passing shall be automatically performed by a controller when a reference to a point

name not located in that controller is entered into the controller's database. An operator/installer shall not be required to set up any communications services to perform internetwork value passing.

G. The time clocks in all controllers shall be automatically synchronized daily.

2.9 INPUT/OUTPUT INTERFACE

A. Hard-wired inputs and outputs may tie into the system through Building, Custom, or Application Specific Controllers.

B. All input points and output points shall be protected such that shorting of the point to itself, another point, or ground will cause no damage to the controller. All input and output points shall be protected from voltage up to 24V of any duration, such that contact with this voltage will cause no damage to the controller.

C. Binary inputs shall allow the monitoring of on/off signals from remote devices. The binary inputs shall provide a wetting current of at least 12 ma to be compatible with commonly available control devices. Binary control function wiring shall be a minimum of number 18 gauge.

D. Pulse accumulation input points. This type of point shall conform to all the requirements of Binary Input points, and also accept up to 2 pulses per second for pulse accumulation, and shall be protected against effects of contact bounce and noise.

E. Analog inputs shall allow the monitoring of low voltage (0-10 Vdc), current (4-20 ma), or resistance signals (thermistor, RTD). Analog inputs shall be compatible with, and field configurable to commonly available sensing devices. RTD wiring shall be two-wire or four-wire twisted, shielded, minimum number 18 gauge.

F. Other analog inputs shall be a minimum of number 18 gauge, twisted, shielded

G. Binary outputs shall provide for on/off operation, or a pulsed low voltage signal for pulse width modulation control. Binary outputs on custom and building controllers shall have 3-position (on/off/auto) override switches and status lights. Outputs shall be selectable for either normally open or normally closed operation.

H. Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide either a 0-10 Vdc or a 4-20 ma signal as required to provide proper control of the output device. Analog outputs on building or custom programmable controllers shall have status lights and a 2-position (auto/manual) switch and manually adjustable potentiometer for manual override.

2.10 AUXILIARY CONTROL DEVICES

A. Motorized dampers, unless otherwise specified elsewhere, shall be as follows:

1. Damper frames shall be 16 gauge galvanized sheet metal or 1/8" extruded aluminum with reinforced corner bracing.
2. Damper blades shall not exceed 8" in width or 48" in length. Blades are to be suitable for medium velocity performance (2,000 fpm). Blades shall be not less than 16 gauge.
3. Damper shaft bearings shall be as recommended by manufacturer for application.

4. All blade edges and top and bottom of the frame shall be provided with compressible seals. Side seals shall be compressible stainless steel. The blade seals shall provide for a maximum leakage rate of 10 CFM per square foot at 2.5" w.c. differential pressure.
5. All leakage testing and pressure ratings will be based on AMCA Publication 500.
6. Individual damper sections shall not be larger than 48" x 60". Provide a minimum of one damper actuator per section.

B. Control dampers shall be parallel or opposed blade type as indicated in the sequence of operation.

C. Electronic damper/valve actuators.

1. The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the rotation of the actuator.
2. Where shown, for power-failure/safety applications, an internal mechanical, spring return mechanism shall be built into the actuator housing.
3. All rotary spring return actuators shall be capable of both clockwise or counter clockwise spring return operation. Linear actuators shall spring return to the retracted position.
4. Proportional actuators shall accept a 0-10 VDC or 0-20 ma control signal and provide a 2-10 VDC or 4-20 ma operating range.
5. All 24 VAC/DC actuators shall operate on Class 2 wiring and shall not require more than 10 VA for AC or more than 8 W for DC applications. Actuators operating on 120 VAC or 230 VAC shall not required more than 11 VA.
6. 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 a manual crank for this purpose.
7. All modulating actuators shall have an external, built-in switch to allow the reversing of direction of rotation
8. Actuators shall be provided with a conduit fitting and a minimum 1m electrical cable and shall be pre-wired to eliminate the necessity of opening the actuator housing to make electrical connections.
9. Actuators shall be Underwriters Laboratories Standard 873 listed.
10. Actuators shall be designed for a minimum of 60,000 full stroke cycles at the actuator's rated torque.

D. Control Valves

1. Control valves shall be two-way or three-way type for two-position or modulating service as scheduled or shown.
2. Close-off (differential) Pressure Rating: Valve actuator and trim shall be furnished to provide the following minimum close-off pressure ratings:

    a. Water Valves:

        1) Two-way: 150% of total system (pump) head.
        2) Three-way: 300% of pressure differential between ports A and B at design flow or 100% of total system (pump) head.

3. Water Valves:

    a. Body and trim style and materials shall be per manufacturer's recommendations for design conditions and service shown, with equal percentage ports for modulating service.

b. Sizing Criteria:

1) Two-position service: Line size.
2) Two-way modulating service: Pressure drop shall be equal to the greater of twice the pressure drop through heat exchanger (load) or 50% of the pressure difference between supply and return mains but not greater than 5 psi unless noted otherwise.
3) Three-way Modulating Service: Pressure drop equal to twice the pressure drop through the coil exchanger (load), 4 psi maximum.
4) Valves 1/2" through 2" shall be bronze body or cast brass ANSI Class 250, spring loaded, Teflon packing, quick opening for two-position service. Two-way valves to have replaceable composition disc, or stainless steel ball.
5) 2-1/2" valves and larger shall be cast iron ANSI Class 125 with guided plug and Teflon packing.

c. Water valves shall fail normally open or closed as indicated in the sequence of operation as follows:

1) Heating coils in air handlers - normally open.
2) Chilled water control valves - normally closed.
3) Other applications - as scheduled or as required by sequence of operation.

d. Zone valves shall be sized to meet the control application and they shall maintain their last position in the event of a power failure.

E. CO2 Sensors

1. CO2 output to controller to be Voltage only. Milli amps is not allowed.

F. Temperature Sensors

1. Temperature sensors shall be Resistance Temperature Device (RTD) or Thermistor.
2. Duct sensors shall be rigid or averaging as shown. Averaging sensors shall be a minimum of 5 feet in length.
3. Immersion sensors shall be provided with a separable stainless steel well. Pressure rating of well is to be consistent with the system pressure in which it is to be installed.
4. Space sensors shall be equipped with override switch and communication port. Provide adjustable feature and display where indicated in the sequence of operation.
5. Provide matched temperature sensors for differential temperature measurement. Differential accuracy shall be within 0.2 F.

G. Humidity Sensors

1. Duct and room sensors shall have a sensing range of 20% to 80% with accuracy of ±5% RH
2. Duct sensors shall be provided with a sampling chamber.
3. Outdoor air humidity sensors shall have a sensing range of 20% to 95% RH. It shall be suitable for ambient conditions of -40 F to 170 F.
4. Humidity sensor's drift shall not exceed 1% of full scale per year.

H. Static Pressure Sensors

1. Sensor shall have linear output signal. Zero and span shall be field-adjustable.

2. Sensor sensing elements shall withstand continuous operating conditions plus or minus 50% greater than calibrated span without damage.
3. Water pressure sensor shall have stainless steel diaphragm construction, proof pressure of 150 psi minimum. Sensor shall be complete with 4-20 ma output, required mounting brackets, and block and bleed valves. Mount in location accessible for service.
4. Water differential pressure sensor shall have stainless steel diaphragm construction, proof pressure of 150 psi minimum. Over-range limit (DP) and maximum static pressure shall be 3,000 psi. Transmitter shall be complete with 4-20 ma output, required mounting brackets, and five-valve manifold. Mount in a location accessible for service.

I. Low Limit Thermostats

1. Safety low limit thermostats shall be vapor pressure type with an element 20 ft. minimum length. Element shall respond to the lowest temperature sensed by any one foot section.
2. Low limit shall be manual reset only.

J. Indoor Air Quality Sensors

1. Indoor air quality sensors shall measure both total percentage VOCs and CO2 in PPM. Sensors shall be duct or space mounted.

K. Flow Switches

1. Flow-proving switches shall be either paddle or differential pressure type.
2. Differential pressure type switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum), NEMA 1 Type enclosure, with scale range and differential suitable for intended application, or as specified.
3. Current sensing relays may be used for flow sensing or terminal devices.

L. Relays

1. Control relays shall be UL listed plug-in type with dust cover. Contact rating, configuration, and coil voltage suitable for application.
2. Time delay relays shall be UL listed solid-state plug-in type with adjustable time delay. Delay shall be adjustable plus or minus 200% (minimum) from set-point shown on plans. Contact rating, configuration, and coil voltage suitable for application. Provide NEMA 1 Type enclosure when not installed in local control panel.

M. Transformers and Power Supplies

1. Each transformer circuit shall be minimum 100va.
2. Transformer commons to be terminated separately per circuit.
3. Control transformers shall be UL listed, Class 2 current-limiting type, or shall be furnished with over-current protection in both primary and secondary circuits for Class 2 service.
4. Unit output shall match the required output current and voltage requirements. Current output shall allow for a 50% safety factor. Output ripple shall be 3.0 mV maximum Peak-to-Peak. Regulation shall be 0.10% line and load combined, with 50 microsecond response time for 50% load changes. Unit shall have built-in over-voltage protection.
5. Unit shall operate between 0 C and 50 C.
6. Unit shall be UL recognized.

N. Current Switches

1. Current-operated switches shall be self-powered, solid state with adjustable trip current. The switches shall be selected to match the current of the application and output requirements of the DDC system.

O. Current Sensors

1. The current sensors shall be designed to be installed or removed without dismantling the primary bus or cables. The transformer shall be of a split core design.
2. The core and windings shall be completely encased in a UL approved thermoplastic rated 94VA. No metal parts shall be exposed other than the terminals.
3. The current sensors shall meet the following specifications:
4. Frequency Limits: 50 to 400 Hz.
5. Insulation: 0.6 KV Class, 10 KV BIL.
6. Accuracy: 1% at 5.0 to 25.0 VA accuracy class with U.P.F. burden.

P. Local Control Panels

1. All indoor control cabinets shall be fully enclosed NEMA 1 Type construction with hinged door, key-lock latch, removable sub-panels. A single key shall be common to all field panels and sub-panels.
2. Interconnections between internal and face-mounted devices pre-wired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL listed for 600-volt service, individually identified per control/interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.
3. Provide on/off power switch with over-current protection and main air gauge for control power sources to each local panel.
4. Provide with slotted wire duct and din rails as indicated on DRAWINGS.
5. Coordinate with DMVA Control Technicians for Control Unit Mounting.
6. Cabinet locations, if not specified on drawings, must be approved by State of Michigan.

2.11 IDENTIFICATION

C. Automatic Control Valve Tags

1. For valves, etc., use metal tags with a 2-inch minimum diameter, fabricated of brass, stainless steel or aluminum. Attach tags with chain of same materials. For lubrication instructions, use linen or heavy duty shipping tag.
2. Tag valves with identifying number and system. Number valves by floor level, column location and system served.
3. Prepare lists of all tagged valves showing location, floor level, and tag number, use. Prepare separate lists for each system. Include copies in each maintenance manual. And post in boiler room.

D. Wire Tags

1. All multi-conductor cables in pull boxes, at end devices, controllers, 6” inside DDC enclosures and terminal strip cabinets shall be labeled.
2. Provide wire Tags as per Division 26.

E. Conduit Tags

1. Provide tagging or labeling of conduit so that it is always readily observable which conduit was installed or used in implementation of this Work.

F. Miscellaneous Equipment Identification

1. Screwed-on, engraved black lamicoid sheet with white lettering on all control panels and remote processing panels. Lettering sizes subject to approval.
2. Inscription, subject to review and acceptance, indicating equipment, system numbers, functions and switches. For panel interior wiring, input/output modules, local control panel device identification.

G. Label any device associated with DDC that is located in a suspended ceiling and/or access panel by labeling the suspended ceiling directly underneath the device. Next to each label affix a ½ diameter orange sticker that signifies a DDC device.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that systems are ready to receive work.

B. Beginning of installation means installer accepts existing conditions.

C. The project plans shall be thoroughly examined for control device and equipment locations, and any discrepancies, conflicts, or omissions shall be reported to the Architect/Engineer for resolution before rough-in work is started.

D. The contractor shall inspect the site to verify that equipment is installable as shown, and any discrepancies, conflicts, or omissions shall be reported to the Architect/Engineer for resolution before rough-in work is started.

E. The Control System Contractor shall examine the drawings and specifications for other parts of the work, and if head room or space conditions appear inadequate or if any discrepancies occur between the plans and his work and the plans for the work of others, he shall report such discrepancies to the Architect/Engineer and shall obtain written instructions for any changes necessary to accommodate his work with the work of others.

3.2 GENERAL WORKMANSHIP

A. Install equipment, piping, wiring/conduit parallel to building lines (i.e. horizontal, vertical, and parallel to walls) wherever possible.

B. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.

C. Install all equipment in readily accessible location as defined by chapter 1 article 100 part A of the NEC. Control panels shall be attached to structural walls unless mounted in equipment enclosure specifically designed for that purpose. Panels shall be mounted to allow for unobstructed access for service.

D. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.

E. All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

F. Install all control components in accordance with manufacturer's instructions and recommendations.

G. Mount control panels adjacent to associated equipment on vibration-free walls or freestanding angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide nameplates for instruments and controls inside cabinet and nameplates on cabinet face. Cabinet locations, if not specified on drawings, must be approved by State of Michigan.

H. After completion of installation, test and adjust control equipment. Submit data showing setpoints and final adjustments of controls.

I. Webserver IP addresses will be provided by DMVA.

J. Where LMFC conduits enter roof mounted mechanical equipment, LFMC must be a minimum of 1” trade size and LFMC must enter in factory provided knockout using approved fittings for such use. If installation is not installed in this manner without prior approval by State of Michigan, contractor is subject to replacing equipment in order to meet this requirement.

3.3 WIRING

A. Install all low voltage power and LON and LAN communication trunks in conduit regardless of local building code allowances otherwise.

B. All control and interlock wiring shall comply with the national and local electrical codes and Division 26 of these specifications. Where the requirements of this section differ with those in Division 26, the requirements of this section shall take precedence.

C. Install all Class 2 wires in conduit in the following locations:

1. Mechanical spaces.
2. Concealed inaccessible walls, chassis, ceiling, etc.

D. Where Class 2 wires are in concealed and accessible locations including ceiling return air plenums, approved cables not in raceway may be used provided that:

1. Circuits meet NEC Class 2 (current-limited) requirements. (Low-voltage power circuits shall be sub-fused when required to meet Class 2 current-limit.)
2. All cables shall be UL listed for application, i.e. cables used in ceiling plenums shall be UL listed specifically for that purpose.

E. Do not install Class 2 wiring in conduit containing Class 1 wiring. Boxes and panels containing high voltage may not be used for low voltage wiring except for the purpose of interfacing the two (e.g. relays and transformers).

F. Where class 2 wiring is run exposed, wiring shall be run parallel along a surface or perpendicular to it, and bundled, using approved wire ties at no greater than 10 ft intervals.

Such bundled cable shall be fastened to the structure, using specified fasteners, at 5 ft intervals or more often to achieve a neat and workmanlike result.

G. All wire-to-device connections shall be made at a terminal blocks or terminal strip. All wire-to-wire connections shall be at a terminal block, with a crimped connector and/or with a UL listed wire nut. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

H. Maximum allowable voltage for control wiring shall be 120V. If only higher voltages are available, the Control System Contractor shall provide step down transformers.

I. All wiring shall be installed as continuous lengths, where possible. Any required splices shall be made only within an approved junction box or other approved protective device. Splices in shielded cables shall consist of terminations and the use of shielded cable couplers, which maintain the integrity of the shielding. Terminations shall be in accessible locations. Cables shall be harnessed with cable ties as specified herein. All wiring it to be installed point to point.

J. Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations in accordance with other sections of this specification and local codes.

K. Size of conduit and size and type of wire shall be the design responsibility of the Control System Contractor, in keeping with the manufacturer's recommendation and NEC.

L. Control and status relays are to be located in designated enclosures only. These relays may also be located within packaged equipment control panel enclosures. These relays shall not be located within Class 1 starter enclosures.

M. Follow manufacturer's installation recommendations for all communication and network cabling. Network or communication cabling shall be run separately from other wiring.

N. Adhere to Division 26 requirements for installation of raceway.

O. This Contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with termination’s identified at the job site.

P. Flexible metal conduits and liquid-tight, flexible metal conduits shall not exceed 3' in length and shall be supported at each end. Flexible metal conduit less than 1/2" electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal conduits shall be used.

3.4 FIBER OPTIC CABLE SYSTEM

A. All cabling shall be installed in a neat and workmanlike manner. Minimum cable and unjacketed fibber bend radii as specified by cable manufacturer shall be maintained.

B. Maximum pulling tensions as specified by the cable manufacturer shall not be exceeded during installation. Post installation residual cable tension shall be within cable manufacture's specifications.

C. Fiber optic cabinets, hardware, and cable entering the cabinet shall be installed in accordance with manufacturers' instructions. Minimum cable and unjacketed fiber bend radii as specified by cable manufacturer shall be maintained.

3.5 INSTALLATION OF SENSORS

A. Install sensors in accordance with the manufacturer's recommendations.

B. Mount sensors rigidly and adequate for the environment within which the sensor operates.

C. Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing.

D. All wires attached to sensors shall be air sealed in their conduits or in the wall to stop air transmitted from other areas affecting sensor readings.

E. Install duct static pressure tap with tube end facing directly down-stream of air flow.

F. Sensors used in mixing plenums, and hot and cold decks shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip.

G. All pipe mounted temperature sensors shall be installed in wells. Install all liquid temperature sensors with heat conducting fluid in thermal wells.

H. Wiring for space sensors shall be concealed in building walls. EMT conduit is acceptable within mechanical and service rooms.

I. Install outdoor air temperature sensors on north wall complete with sun shield at designated location.

J. Temperature sensor assemblies shall be readily accessible and adaptable to each type of application in such manner as to allow for quick, easy replacement and servicing without special tools or skills.

K. Outdoor installations shall be of weatherproof construction or in appropriate NEMA enclosures. These installations shall be protected from solar radiation and wind effects. Protective shield shall be stainless steel.

L. Sensors in ducts shall be mounted in locations to sense the correct temperature of the air only and shall not be located in dead air spaces or positions obstructed by ducts, equipment, and so forth. Locations where installed shall be within the vibration and velocity limit of the sensing element. Ducts shall be securely sealed where elements or connections penetrate ducts to avoid measuring false conditions.

M. All sensors measuring temperatures in pipes larger than 2 inches in diameter or in pressure vessels shall be supplied with wells properly fabricated for the service. Wells shall be noncorrosive to the medium being measured and shall have sufficient physical strength to withstand pressures and velocities to which they are subjected. Wells shall be installed in the piping at elbows where piping is smaller than the length of the well to affect proper flow across the entire area of the well.

3.6 FLOW SWITCH INSTALLATION

A. Install using a thread-o-let in steel pipe. In copper pipe use C x C x F Tee, no pipe extensions or substitutions allowed.

B. Mount a minimum of 5 pipe diameters up stream and 5 pipe diameters downstream or 2 feet which ever is greater, from fittings and other obstructions.

C. Install in accordance with manufacturers instructions.

D. Assure correct flow direction and alignment.

E. Mount in horizontal piping - flow switch on top of the pipe.

3.7 ACTUATORS

A. Mount and link control damper actuators per manufacturer's instructions.

B. To compress seals when spring return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close the damper, and then tighten the linkage.

C. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.

D. Valves - Actuators shall be mounted on valves with adapters approved by the actuator manufacturer. Actuators and adapters shall be mounted following manufacturer's recommendations.

3.8 WARNING LABELS

A. Affix plastic labels on each starter and equipment automatically controlled through the Control System. Label shall indicate the following:

C A U T I O N This equipment is operating under automatic control and may start at any time without warning.

3.9 IDENTIFICATION OF HARDWARE AND WIRING

A. All wiring and cabling, including that within factory-fabricated panels, shall be labeled at each end within 2" of termination with a cable identifier and other descriptive information.

B. Permanently label or code each point of field terminal strips to show the instrument or item served.

C. Identify control panels with minimum 1 cm letters on laminated plastic nameplates.

D. Identify all other control components with permanent labels. Identifiers shall match record documents. All plug-in components shall be labeled such that removal of the component does not remove the label.

E. Identify room sensors relating to terminal box or valves with nameplates.

3.10 CONTROLLERS

A. Provide a separate Controller for each major piece of HVAC equipment. Points used for control loop reset such as outside air or space temperature are exempt from this requirement.

B. Building Controllers and Custom Application Controllers shall be selected to provide a minimum of 15% spare I/O point capacity for each point type found at each location. If input points are not universal, 15% of each type is required. If outputs are not universal, 15% of each type is required. A minimum of one spare is required for each type of point used.

C. Future use of spare capacity shall require providing the field device, field wiring, point database definition, and custom software. No additional Controller boards or point modules shall be required to implement use of these spare points.

3.11 PROGRAMMING

A. Provide sufficient internal memory for the specified control sequences and trend logging. There shall be a minimum of 25% of available memory free for future use.

B. Point Naming: System point names shall be modular in design, allowing easy operator interface without the use of a written point index.

1. Coordinate with Owner for point naming nomenclature.

C. Software Programming

1. Provide programming for the system as per specifications and adhere to the strategy algorithms provided. All other system programming necessary for the operation of the system but not specified in this document shall also be provided by the Control System Contractor. Imbed into the control program sufficient comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in the sequence of operations.

D. The BAS database shall be developed utilizing a LonWorks LNS network software tool. This software tool shall be Circon Systems (EBAC) Network Integrator.

E. All database development must be performed with this LNS tool including controller and component population of the database, programming, data bindings and commissioning.

F. LNS “Plug-ins” must be available, and furnished with the database, for configuration and programming of the main systems controllers.

G. At completion of the project, a complete LNS database backup must be furnished to the owner that includes all programming files and data bindings (peer-to-peer data shared between controllers). Imbedded within the LNS database backup shall be a database backup of the CatNet Web server.

H. All passwords, software tools, or other items required for the Owner to independently operate, access, program, or modify the BAS must be furnished at project completion.

I. Any other database development software, method or type is strictly forbidden.

J. All Source code including any and all relevant files need to be handed over to the State of Michigan representative at time of commissioning. Include any/all customs function blocks or UDD needed in order to run the program in real time.

K. Operators' Interface

1. Standard Graphics. Provide graphics for each major piece of equipment and floor plan in the building. This includes each Chiller, Air Handler, HVAC Unit, VAV Terminal, Fan Coil, Boiler, Heat Exchanger and Cooling Tower. These standard graphics shall show all points dynamically as specified in the points list.
2. The controls contractor shall provide all the labor necessary to install, initialize, start-up, and trouble-shoot all operator interface software and their functions as described in this section. This includes any operating system software, the operator interface data base, and any third party software installation and integration required for successful operation of the operator interface.
3. As part of this execution phase, the controls contractor will perform a complete test of the operator interface. Test duration shall be a minimum of 16 hours on-site. Tests shall be made in the presence of the Owner or Owner's representative.

L. Demonstration: A complete demonstration and readout of the capabilities of the monitoring and control system shall be performed with DMVA controls technicians. The contractor shall dedicate a minimum of 16 hours on-site with the Owner and his representatives for a complete functional demonstration of all the system requirements. This demonstration constitutes a joint acceptance inspection, and permits acceptance of the delivered system for on-line operation.

M. Adjustments: Provide up to 4 additional site visits during the first year of operation to adjust systems and provide owner instruction as required for seasonal adjustments.

3.12 CLEANING

A. This contractor shall clean up all debris resulting from his or her activities daily. The contractor shall remove all cartons, containers, crates, etc. under his control as soon as their contents have been removed. Waste shall be collected and placed in a location designated by the Construction Manager or General Contractor.

B. At the completion of work in any area, the Contractor shall clean all of his/her work, equipment, etc., making it free from dust, dirt and debris, etc.

C. At the completion of work, all equipment furnished under this Section shall be checked for paint damage, and any factory finished paint that has been damaged shall be repaired to match the adjacent areas. Any metal cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

3.13 PROTECTION

A. The Contractor shall protect all work and material from damage by his/her work or workers, and shall be liable for all damage thus caused.

B. The Contractor shall be responsible for his/her work and equipment until finally inspected, tested, and accepted. The Contractor shall protect his/her work against theft or damage, and shall carefully store material and equipment received on site that is not immediately installed.

The Contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.14 TRAINING

A. Provide a minimum of 1 classroom training sessions, 4 hours each, throughout the contract period for personnel designated by the Owner. Computer based training may be substituted for up to 24 hours of hands on training.

B. Train the designated staff of Owner's representative and Owner to enable them to proficiently operate the system; create, modify and delete programming; add, remove and modify physical points for the system; add additional panels when required.

C. These objectives will be divided into three logical groupings; participants may attend one or more of these, depending on level of knowledge required:

1. Day-to-day Operators
2. System Troubleshooter
3. System Manager: parts

D. Provide course outline and materials as per Part 1 of this Section. The instructor(s) shall provide one copy of training material per student.

E. The instructor(s) shall be factory-trained instructors experienced in presenting this material.

F. Classroom training shall be done using a network of working controllers representative of the installed hardware or at the customers site.

3.15 FIELD QUALITY CONTROL

A. All work, materials and equipment shall comply with the rules and regulations of applicable local, state, and federal codes and ordinances as identified in Part 1 of this Section.

B. Contractor shall continually monitor the field installation for code compliance and quality of workmanship. All visible piping and or wiring runs shall be installed parallel to building lines and properly supported.

C. Contractor shall arrange for field inspections by local and/or state authorities having jurisdiction over the work.

3.16 ACCEPTANCE

A. The control systems will not be accepted as meeting the requirements of Completion until all tests described in this specification have been performed to the satisfaction of both the Engineer and Owner. Any tests that cannot be performed due to circumstances beyond the control of the Contractor may be exempt from the Completion requirements if stated as such in writing by the Owner's representative. Such tests shall then be performed as part of the warranty.

B. Final as-built documentation must include the following:

1. Accurate wire color for device termination.
2. Accurate flow diagrams showing correct devices installed.
3. Accurate part number that are actually installed.
4. Physical location of all installed cabinets.

C. DMVA Commissioning of system shall be done prior to substantial completion acceptance. General Contractor WILL NOT be given substantial completion until State of Michigan control technicians approve installation of DDC.

1. The following items will need to be complete before DMVA commissioning will be scheduled:

    a. Accurate set of as-builts control drawings.
    b. all equipment installed or modified under contract must be operational.
    c. Operator's workstation with all software and current LNS database installed shall be onsite.
    d. Any RFI pertaining to controls printed on paper and on site and associate bulletins/change orders.
    e. All DDC labeling to be completed.
    f. Construction drawings and spec book on site

END OF SECTION 230900

SECTION 230993

SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes control sequences for HVAC systems, subsystems, and equipment.

B. This Section describes the minimum performance requirements for the systems and does not necessarily include all elements of control required for proper and safe operation of the systems. The Contractor shall provide all necessary safeties interlocks, high limits, low limits, time delays, and control logic for a complete and operable system.

C. Related Sections include the following:

1. Division 23 Section "Instrumentation and Controls for HVAC" for control equipment and devices and submittal requirements.

D. All equipment, valves, fans, etc, shall be controlled by the temperature control contractor unless specified to be controlled by another method in the specifications or the construction documents.

1.3 DEFINITIONS

A. DDC: Direct-digital controls.

B. BAS: Building Automation System.

1.4 AIR HANDLING UNIT SEQUENCE (AHU-1 AND AHU-2)

A. General:

1. Fan Control: BAS starts and stops supply fan(s) as required for the sequence of operation and occupancy schedules. Current sensing relays on the fan motor monitors fan operation and alarms if fan fails. Fans run continuously during

occupancy and intermittently during unoccupied cycle. Shut down the AHU and alarm BAS if unsafe operating conditions occur.

2. Freeze Protection: Freeze stat with averaging element located downstream of cooling coil monitors leaving air temperature and shuts down unit fan if leaving air temperature falls below 37 deg F, and alarms BAS.
3. Fan/Damper Interlock: Outdoor air damper closes and return air damper opens whenever fan is off. Prove any system dampers open before fans can start.
4. Smoke Control: Duct smoke detector (supplied by Division 28) is mounted in the return air and supply air duct for each unit. Interlock detectors with air handling unit fans so that fans stop when smoke is detected. Monitor remote smoke dampers and interlock with AHU so that AHU does not operate if dampers fail to open.
5. Outdoor Air/Economizer Control: Interlock outdoor and return air dampers to operate in sequence. Outdoor air damper is closed during unoccupied cycle and opens to specified minimum position during occupied hours.
    a. During occupied hours, BAS to monitor CO2 levels in the occupied space with CO2 sensor mounted in the return air duct. When the CO2 levels are less than 800 PPM, the outdoor air damper can reduce to 10% open (adjustable). If the CO2 levels are 800 PPM or greater, outdoor air damper is to open to specified minimum position.

    Monitor supply air temperature, return air temperature and humidity, and outdoor air temperature and humidity. When outdoor enthalpy is less than return air enthalpy, modulate outdoor open and return air dampers closed in sequence with cooling control valves as required to maintain 55 deg F (adjustable) supply temperature. When outdoor air enthalpy is above return air enthalpy, outdoor air damper returns to minimum position setting. Prove relief damper (D-1 for AHU-1 and D-2 for AHU-2) open before outside air exceeds 50% open.
6. Warm-Up Control: Whenever outdoor temperature is below 55 deg F (adjustable) and system status changes from unoccupied to occupied mode, BAS initiates a warm-up sequence. Hold outdoor air damper closed and return air damper open and activate heating coil to raise discharge air temperature to 80 deg F until return air temperature rises to within 3 deg F (adjustable) of space setpoint.
7. High Discharge Air Pressure Limit Control: Monitor discharge air pressure in supply ductwork upstream of any fire dampers. Stop supply fan if duct pressure rises 2 inches above normal operating pressure and alarm system.
8. Filter Pressure Drop: Monitor air handling unit filter pressure drop gauges (refer to Section 237313 for gauge specification) and alarm system when pressure drop exceeds high or low limit settings.

B. Variable Air Volume Units:

1. Equipment Controlled:
    a. AHU-1/CU-1 & P-4
    b. AHU-2/CU-2 & P-5

2. Unit Components: Supply fan(s) with VFDs, cooling coil, heating coil, mixing box (outside air dampers, and return dampers). See Division 26 for VFD Specifications.
3. Occupancy Control: Unit fan is on during occupied hours and off during unoccupied hours.

4. Supply Air Pressure Control: BAS monitors supply air pressure (2/3 downstream) and modulates supply fan speed through VFD to maintain duct static pressure at 1.5 inch wc (adjustable). BAS to also monitor box positions and reduce static pressure setpoint to allow for at least one box to be 95% open (static pressure reset).
5. Cooling Coil Control: BAS to modulate the condensing unit compressors as required to maintain 55 deg F (adjustable) discharge temperature.
6. Heating Coil Control: Heating coil pump (P-4 for AHU-1 and P-5 for AHU-2) starts whenever outdoor temperature is below 45 deg F (adjustable) or on a call for heating. BAS modulates 3-way CV as required to maintain 55 deg F (adjustable) supply temperature. Lock out economizer and cooling when heating is activated. When the unit is off, modulate the Heating CV to maintain 55 deg F inside the AHU. Monitor coil pump through current sensing relays. If pump fails close outdoor air damper and alarm BAS.
7. Outside Air Control: BAS monitors AHU outside air damper flow monitor devise and resets OA/RA dampers as required to maintain specified minimum outside air flow (adjustable).
8. Relief Dampers: Interlock outside air and relief air damper. BAS monitors building pressurization. When building pressure exceeds 0.02 inch positive pressure (adjustable), open relief damper (D-1 for AHU-1 and D-2 for AHU-2). Modulate relief damper as required to maintain 0.02 inches wc (adjustable) building pressure. Alarm BAS and stop AHU if building pressure exceeds 0.2 inch wc (adjustable).

C. Monitor and/or control the following:

1. System graphic.
2. Supply fan status.
3. Supply fan failure alarm status.
4. Supply fan VFD speed.
5. Supply fan VFD failure alarm.
6. Occupancy status.
7. Freeze stat alarm status.
8. OA damper flow (cfm).
9. OA damper position.
10. OA damper minimum setpoint.
11. OA temperature.
12. OA RH.
13. Return air damper position.
14. Return air CO2 PPM
15. Relief air damper position.
16. Economizer status.
17. Discharge air temperature.
18. Discharge air temperature setpoint.
19. Supply air pressure.
20. Supply air pressure setpoint.
21. High limit supply air pressure alarm status.
22. Filter high limit status.
23. Filter low limit status.
24. Building pressure.

25. Building pressure setpoint.
26. Building pressure high limit alarm.
27. Heating coil CV position.
28. Heating coil pump status.
29. Heating coil pump alarm.
30. Condensing unit status
31. Condensing unit stage
32. Condensing unit alarm

1.5 ROOF TOP UNIT SEQUENCE

A. Equipment Controlled:

1. RTU-1, RTU-HC-1, and P-6
2. RTU-2, RTU-HC-2, and P-7
3. RTU-3, RTU-HC-3, and P-8
4. RTU-4, RTU-HC-4, and P-10
5. RTU-5, RTU-HC-5, and P-11

B. Packaged roof top unit to be equipped with a factory provided DDC controls ready package/terminal strip that allows the BAS to modulate fans, modulate compressors during cooling mode, and modulate remote mounted hydronic heating coil control valve during heating mode. The BAS will be able to module the heating coil control valve and operate the heating coil pump. The BAS will control the entire rooftop unit system. BAS to monitor all RTU control points and be capable of adjusting temperature setpoints and schedules.

C. RTU-1, RTU-2, and RTU-3: BAS monitors discharge air temperature. BAS to modulate the unit and remote mounted heating coil as required to maintain 55 deg F (adjustable) discharge temperature. Discharge air temperature and schedules to be adjusted through the BAS.

D. RTU-4 and RTU-5: BAS monitors space temperature. Controls contractor provided thermostat that is connected to the BAS.

1. Zone Optimal Start: The unit shall use an optimal start algorithm for morning start-up. This algorithm shall minimize the unoccupied warm-up or cool-down period while still achieving comfort conditions by the start of scheduled occupied period.
2. Zone Unoccupied Override: A timed local override control shall allow an occupant to override the schedule and place the unit into an occupied mode for an adjustable period of time. At the expiration of this time, control of the unit shall automatically return to the schedule.
3. Zone Setpoint Adjustment: The occupant shall be able to adjust the zone temperature heating setpoint at the zone thermostat. Limit adjustment from BAS temperature setpoint to +/- 3 deg F.

E. General:

1. Fan Control: BAS to control the start and stop of supply fan(s) as required for the sequence of operation and occupancy schedules. Current sensing relays on the fan motor monitors fan operation and alarms if fan fails. Fan runs continuously during occupancy and intermittently during unoccupied cycle. Shut down the RTU and alarm BAS if unsafe operating conditions occur.

    a. RTU-1, RTU-2, and RTU-3: BAS monitors supply air pressure (2/3 downstream) and modulates the supply fan(s) speed through VFD to maintain duct static pressure at 1.5 inch wc (adjustable). BAS to also monitor box positions and reduce static pressure setpoint to allow for at least one box to be 95% open (static pressure reset). During cooling mode, BAS modulates the condensing unit compressors as required to maintain 55 deg F discharge temperature. During heating mode, the heating coil pump starts whenever outdoor temperature is below 45 deg F (adjustable) or on a call for heating. The control valve modulates hydronic flow across to the coil to maintain 55 deg F (adjustable) supply temperature. When the unit is off, modulate the heating CV to maintain 55 deg F inside the supply duct. Monitor coil pump through current sensing relays. If heating coil pump fails close outdoor air damper and alarm BAS.

    b. RTU-4 and RTU-5: Where called in the schedule to provide single zone VAV sequence. During cooling mode when the zone is at design sensible cooling load the system shall supply full airflow at the design supply air temperature (55 degree F). As the zone cooling load decreases, the supply airflow shall be reduced as needed to maintain the desired temperature in the room while maintaining a 55 degree discharge air temperature. Cooling capacity shall then be modulated (through compressor or economizer depending on the outdoor and indoor air conditions) to maintain the supply air temperature and room setpoint. After the supply fan reaches its minimum limit, the fan shall remain at its minimum airflow but the supply air temperature setpoint shall gradually reset upward to avoid overcooling the zone. During heating mode, the fan shall operate at a minimum airflow and the supply air temperature setpoint is increased. The heating coil pump starts whenever outdoor temperature is below 45 deg F (adjustable) or on a call for heating. The control valve modulates hydronic flow across to the coil to maintain the space air temperature. When the heating load increases the supply airflow shall increase while the modulating control valve modulates hydronic flow across the coil to maintain space temperature setpoint. When the unit is off, modulate the heating CV to maintain 55 deg F inside the supply duct. Monitor coil pump through current sensing relays. If heating coil pump fails close outdoor air damper and alarm BAS.

2. Smoke Control: Duct smoke detector (supplied by Division 28) is mounted in the return air and supply air duct for each unit where required by code. Interlock detectors with rooftop unit fans so that fans stop when smoke is detected. Monitor remote smoke dampers and interlock with roof top unit so that roof top unit does not operate if dampers fail to open.

3. Fan/Damper Interlock: Outdoor air damper closes and return air damper opens whenever fan is off. Prove any system dampers open before fans can start.

4. Outdoor Air/Economizer Control: Interlock outdoor and return air dampers to operate in sequence. Outdoor air damper is closed during unoccupied cycle and opens to specified minimum position during occupied hours.
    a. During occupied hours, BAS to monitor CO2 levels in the occupied space with CO2 sensor mounted in the return air duct. When the CO2 levels are less than 800 PPM, the outdoor air damper can reduce to 10% open (adjustable). If the CO2 levels are 800 PPM or greater, outdoor air damper is to open to specified minimum position.
    b. Monitor supply air temperature, return air temperature and humidity, and outdoor air temperature and humidity. When outdoor enthalpy is less than return air enthalpy, modulate outdoor open and return air dampers closed in sequence with cooling control valves as required to maintain 55 deg F supply temperature or space temperature setpoint. When outdoor air enthalpy is above return air enthalpy, outdoor air damper returns to minimum position setting. Roof top unit control panel to activate power exhauster. Prove power exhaust activation prior to outside air damper exceeding 50% open.
5. Warm-Up Control: Whenever outdoor temperature is below 55 deg F (adjustable) and system status changes from unoccupied to occupied mode, BAS initiates a warm-up sequence. Hold outdoor air damper closed and return air damper open and activate heating coil to raise discharge air temperature to 90 deg F until return air temperature rises to within 3 deg F (adjustable) of space setpoint.
6. Filter Pressure Drop: Monitor roof top unit filter pressure drop gauges and alarm system when pressure drop exceeds high or low limit settings.
7. Cooling Coil Control: BAS to modulate compressors in sequence with economizer cycle as required to maintain space temperature or desired supply temperature setpoint.
8. Heating Coil Control: BAS to activate heating coil pump whenever outdoor temperature is below 45 deg F (adjustable) or on a call for heating. Rooftop unit control panel to modulate hydronic control valve flow as required to maintain space temperature or desired supply temperature setpoint.
9. BAS to Lock out economizer and cooling when heating is activated.

F. BAS to display and/or Control the following:

1. System graphic.
2. Supply fan status.
3. Supply fan failure alarm status.
4. Supply fan VFD speed.
5. Supply fan VFD failure alarm.
6. Supply air pressure.
7. Supply air pressure setpoint (RTU-1, RTU-2, and RTU-3).
8. Occupancy status.
9. Freeze stat alarm status.
10. OA damper flow (cfm).
11. OA damper position.
12. OA damper minimum setpoint.
13. OA temperature.
14. OA RH.
15. Return air damper position.

16. Return air CO2 PPM
17. Relief air damper position.
18. Economizer status.
19. Discharge air setpoint (RTU-1, RTU-2, and RTU-3).
20. Discharge air temperature.
21. High limit supply air pressure alarm status.
22. Filter high limit status.
23. Filter low limit status.
24. Building pressure.
25. Building pressure high limit alarm.
26. Heating coil CV position.
27. Heating coil pump status.
28. Heating coil pump alarm.
29. Powered exhaust status
30. Space temperature (RTU-4, and RTU-5).
31. Space temperature setpoint (RTU-4, and RTU-5).
32. Heating coil leaving air temperature.
33. Cooling status
34. Cooling stage
35. Cooling alarm

1.6 ENERGY RECOVERY UNIT SEQUENCE

A. Equipment Controlled:

1. ERV-1, ERV-HC-1, and P-13
2. ERV-2, ERV-HC-2, and P-9

B. Packaged energy recovery unit to be provided with a factory provided DDC controls ready package/terminal strip that allows the BAS to modulate fans, modulate compressors during cooling mode, and modulate remote mounted hydronic heating coil control valve during heating mode. The BAS must also be able to module the heating coil control valve and operate the heating coil pump. The BAS must also be capable of controlling the energy recovery unit system. BAS to monitor all ERV control points and be capable of adjusting temperature setpoints and schedules.

C. BAS monitors space temperature. Controls contractor provided thermostat that is connected to the BAS.

1. Zone Optimal Start: The unit shall use an optimal start algorithm for morning start-up. This algorithm shall minimize the unoccupied warm-up or cool-down period while still achieving comfort conditions by the start of scheduled occupied period.
2. Zone Unoccupied Override: A timed local override control shall allow an occupant to override the schedule and place the unit into an occupied mode for an adjustable period of time. At the expiration of this time, control of the unit shall automatically return to the schedule.

3. Zone Setpoint Adjustment: The occupant shall be able to adjust the zone temperature heating setpoint at the zone thermostat. Limit adjustment from BAS temperature setpoint to +/- 3 deg F.

D. General:

1. Fan Control: BAS controls the start and stop of the supply fan and exhaust fan as required for the sequence of operation and occupancy schedules. Current sensing relays on the fan motor monitors fan operation and alarms if a fan fails. Fans run continuously during occupancy and intermittently during unoccupied cycle. Shut down the energy recovery unit and alarm BAS if unsafe operating conditions occur.

    a. During cooling mode, BAS modulates the condensing unit compressors as required to maintain space temperature setpoint. During heating mode, the heating coil pump starts whenever outdoor temperature is below 45 deg F (adjustable) or on a call for heating. The control valve modulates hydronic flow across to the coil to maintain space temperature setpoint. When the unit is off, modulate the heating CV to maintain 55 deg F inside the supply duct. Monitor coil pump through current sensing relays. If heating coil pump fails close outdoor air damper and alarm BAS.

2. Smoke Control: Duct smoke detector (supplied by Division 28) is mounted in the exhaust air and supply air duct for each unit as required by code. Interlock detectors with air energy recovery unit fans so that fans stop when smoke is detected. Monitor remote smoke dampers and interlock with ERV so that ERV does not operate if dampers fail to open.

3. Fan/Damper Interlock: Outdoor air damper and exhaust air damper close whenever supply/exhaust fans are off. Prove any system dampers open before fans can start. Outdoor air damper and exhaust air damper open whenever when supply/exhaust fans are on.
4. Filter Pressure Drop: Monitor energy recovery unit filter pressure drop gauges and alarm system when pressure drop exceeds high or low limit settings.
5. Cooling Coil Control: BAS to modulate compressors as required to maintain space temperature setpoint.
6. Heating Coil Control: BAS to activate heating coil pump whenever outdoor temperature is below 45 deg F (adjustable) or on a call for heating. BAS to modulate hydronic control valve flow as required to maintain space temperature setpoint.
7. BAS to Lock out cooling when heating is activated.

E. BAS to display and/or Control the following:

1. System graphic.
2. Supply fan status.
3. Supply fan failure alarm status.
4. Supply fan VFD speed.
5. Supply fan VFD failure alarm.
6. Exhaust fan status.

7. Exhaust fan failure alarm status.
8. Exhaust fan VFD speed.
9. Exhaust fan VFD failure alarm.
10. Occupancy status.
11. Freeze stat alarm status.
12. OA damper flow (cfm).
13. OA damper position.
14. OA temperature.
15. OA RH.
16. EA damper flow (cfm).
17. EA damper position.
18. EA temperature
19. EA RH
20. Discharge air temperature.
21. Space temperature.
22. Space temperature setpoint.
23. Filter high limit status.
24. Filter low limit status.
25. Heating coil CV position.
26. Heating coil pump status.
27. Heating coil pump alarm.
28. Heating coil leaving air temperature.
29. Cooling status
30. Cooling stage
31. Cooling alarm

1.7 MAKE-UP AIR UNIT SEQUENCE

A. Equipment Controlled:

1. MAU-1, MAU-HC-1, and P-12

B. Packaged make-up air unit to be provided with a factory provided DDC controls ready package/terminal strip that allows the BAS to modulate fan(s), modulate compressors during cooling mode, and modulate remote mounted hydronic heating coil control valve during heating mode. The BAS will be able to module the heating coil control valve and operate the heating coil pump. The BAS will control the entire make-up air unit system. BAS to monitor all MAU control points and be capable of adjusting temperature setpoints and schedules.

C. BAS monitors space temperature. Controls contractor provided thermostat that is connected to the BAS.

1. Zone Optimal Start: The unit shall use an optimal start algorithm for morning start-up. This algorithm shall minimize the unoccupied warm-up or cool-down period while still achieving comfort conditions by the start of scheduled occupied period.
2. Zone Unoccupied Override: A timed local override control shall allow an occupant to override the schedule and place the unit into an occupied mode for

an adjustable period of time. At the expiration of this time, control of the unit shall automatically return to the schedule.

3. Zone Setpoint Adjustment: The occupant shall be able to adjust the zone temperature heating setpoint at the zone thermostat. Limit adjustment from BAS temperature setpoint to +/- 3 deg F.

D. General:

1. Fan Control: BAS controls to start and stop the supply fan(s) as required for the sequence of operation and occupancy schedules. Current sensing relays on the fan motor monitors fan operation and alarms if fan fails. Fan runs continuously during occupancy and intermittently during unoccupied cycle. Make-up air unit is to be interlocked with the kitchen hood exhaust fan. Make-up air unit shall be in occupied mode whenever the kitchen hood exhaust fan is activated. Make-up air unit shall be in unoccupied mode whenever the kitchen hood exhaust fan is off. Shut down the make-up air unit and alarm BAS if unsafe operating conditions occur.

    a. During cooling mode, BAS modulates the condensing unit compressors as required to maintain space temperature setpoint. During heating mode, the heating coil pump starts whenever outdoor temperature is below 45 deg F (adjustable) or on a call for heating. The modulating control valve modulates hydronic flow across to the coil to maintain space temperature setpoint. When the unit is off, modulate the heating CV to maintain 55 deg F inside the supply duct. Monitor coil pump through current sensing relays. If heating coil pump fails close outdoor air damper and alarm BAS.

2. Fire Alarm: Make-up air unit to be interlocked with kitchen exhaust hood. If kitchen exhaust food fire suppression system is triggered, the make-up air unit is to shut down.
3. Fan/Damper Interlock: Outdoor air damper closes and return air damper opens when unit is in unoccupied mode. Prove any system dampers open before fans can start.
4. Filter Pressure Drop: Monitor make-up air unit filter pressure drop gauges and alarm system when pressure drop exceeds high or low limit settings.
5. Cooling Coil Control: BAS modulates compressors as required to maintain space temperature setpoint.
6. Heating Coil Control: BAS to activate heating coil pump whenever outdoor temperature is below 45 deg F (adjustable) or on a call for heating. BAS to modulate hydronic control valve flow as required to maintain space temperature setpoint.
7. BAS to lock out cooling when heating is activated.

E. BAS to display and/or Control the following:

1. System graphic.
2. Supply fan status.
3. Supply fan failure alarm status.
4. Supply fan VFD speed.
5. Supply fan VFD failure alarm.

6. Occupancy status.
7. Kitchen exhaust fan status.
8. Freeze stat alarm status.
9. OA damper flow (cfm).
10. OA damper position.
11. OA damper minimum setpoint.
12. OA temperature.
13. OA RH.
14. Return air damper position.
15. Discharge air temperature.
16. Space temperature.
17. Space temperature setpoint.
18. Filter high limit status.
19. Filter low limit status.
20. Heating coil CV position.
21. Heating coil pump status.
22. Heating coil pump alarm.
23. Heating coil leaving air temperature.
24. Cooling status
25. Cooling stage
26. Cooling alarm

1.8 VAV BOX SEQUENCE

A. Equipment Controlled: VAV boxes (VAV-1 – VAV-53) and perimeter fin tube.

B. Cooling Only VAV: BAS monitors space temperature and modulate box damper from minimum to maximum setting as required to maintain space setpoint. Reset damper position as required to maintain required airflow under varying supply pressure. Space temperature setpoint shall be capable of being controlled by BAS.

1. Zone Setpoint Adjustment: The occupant shall be able to adjust the zone temperature heating setpoint at the zone thermostat. Limit adjustment from BAS temperature setpoint to +/- 3 deg F.

2. Morning Warm-Up: Open box to maximum during morning warm-up until space temperature reaches setpoint. Close damper if space temperature reaches 5 deg F above setpoint and cooling is unavailable.
3. Overcooling Control: During occupied status, reset box minimum to zero if space temperature falls more than 2 deg F below setpoint.
4. With Perimeter Heat: BAS activates 2 way, 2 position CV on remote heat (i.e. radiant fine tube) when space temperature falls below heating setpoint. BAS modulates damper as required to maintain heating setpoint. Remote heat (FTA) CV closes when space temperature rises 2 deg F above setpoint (adjustable).

C. Display and/or Control the following:

1. System graphic.
2. Box occupancy status.

3. Space temperature.
4. Space heating setpoint (occupied and unoccupied).
5. Space cooling setpoint (occupied and unoccupied).
6. Box damper position.
7. Box airflow cfm.
8. Box minimum position setting.
9. Box maximum position setting.
10. Remote heat control valve position (where applicable)

1.9 FIN TUBE CONTROL

A. Radiant Fin Tube Control: FT-1 – FT-8

1. BAS monitors space temperature and modulates 2-way, CV as required to maintain space temperature. Space temperature setpoint shall be capable of being controlled by BAS.
2. Zone Setpoint Adjustment: The occupant shall be able to adjust the zone temperature heating setpoint at the zone thermostat. Limit adjustment from BAS temperature setpoint to +/- 3 deg F.

B. Display and/or control the following:

1. Space temperature (occupied and unoccupied).
2. Space temperature setpoint.
3. CV status or position.

1.10 EXISTING FIN TUBE CONTROL

A. Radiant Fin Tube Control: X-FT

1. BAS monitors space temperature and modulates 2-way, CV as required to maintain space temperature. Space temperature setpoint shall be capable of being controlled by BAS.
2. Zone Setpoint Adjustment: The occupant shall be able to adjust the zone temperature heating setpoint at the zone thermostat. Limit adjustment from BAS temperature setpoint to +/- 3 deg F.

B. Display and/or control the following:

1. Space temperature (occupied and unoccupied).
2. Space temperature setpoint.
3. CV status or position.

1.11 PRIMARY HEATING SYSTEM

A. Equipment Controlled:

1. Boilers: B-1 and B-2.
2. Pumps: P-1 and P-2.

B. The boilers are to be equipped with internal controls that allows the boiler internal control panels to control sequencing of all boilers and associated boiler control valves as required to maintain loop supply water temperature (140-degree F, adjustable) at the optimum efficiencies based on outdoor air temperature reset schedule (adjustable). The boilers shall alternate all boilers being the lead and standby boilers to even run time. Before a boiler starts the associated boiler control valve shall open. If the boiler internal control panel turns a boiler off, the boiler's control valve shall close. If a boiler fails, start standby boiler and alarm BAS. If all the boilers are off, but the heating system is activated the control valve for the next boiler to fire on a call for heat shall remain open to avoid deadheading the pump.

C. Each boiler is to have their own outdoor air sensor installed to allow boilers to run standalone in a control panel failure event.

D. BAS to send signal to boiler(s) control panel to activate the heating system whenever the outdoor temperature is below 55 deg F (adjustable).

E. Hot water supply loop temperature shall be capable of being changed from the BAS and include an outdoor air reset schedule (adjustable).

1. Reset Schedule: Reset the supply water temperature from 140 deg F to 120 deg F (adjustable) as outdoor temperature goes from -10 deg F to 55 deg F (adjustable).
2. Alarm system if supply water temperature falls 20 deg F below setpoint for more than 5 minutes.

F. Pumps P-1 and P-2 shall operate in a lead/lag arrangement with one pump operating in lead mode and the other pump in standby (lag) mode. The BAS activates the lead pump whenever the outdoor temperature is below 55 deg F (adjustable). Each pump is equipped with a variable frequency drive (VFD). The BAS will modulate the VFDs on the lead/lag pumps as required to maintain the system differential pressure setpoint. Provide differential pressure sensors installed in the mechanical room. The BAS monitors current sensing relays on the pump to verify its operating status and alarms if the pump fails. Standby pump is activated if the lead pump fails. Pump operation rotates lead/lag status to even pump wear.

G. All boilers and pumps are to be tied to the new BAS and be integrated on to the new front-end graphics.

H. Operator Station: Control and/or display the following:

1. System graphic.
2. Outdoor temperature.
3. Each boiler status
4. Each boiler control valve position
5. Each boiler alarm status
6. Discharge water temperature for each boiler.

7. Entering water temperature for each boiler.
8. Hot water loop supply water temperature
9. Hot water loop supply water temperature setpoint
10. Hot water loop return water temperature
11. Emergency shut down status
12. Each pump status
13. Each pump alarm
14. Each pump VFD speed
15. Differential pressure of system
16. Differential pressure setpoint of system

1.12 HYDRONIC UNIT HEATER SEQUENCE

A. Equipment Controlled: UH-1, UH-2, UH-3, UH-4, UH-5, UH-6, UH-7, UH-8, and X-UH (Military Maintenance 179).

B. Unit heaters are to be tied to manufacturer provided space thermostat. BAS to monitor space temperature. On a call for heat the BAS shall open the two-position control valve and turn fan on as required to maintain space heating setpoint. When setpoint is met BAS shall close two position valve and turn fan off. Lock out fans when heating system is off. Space temperature setpoint shall be capable of being controlled by the BAS.

C. Zone Setpoint Adjustment: The occupant shall be able to adjust the zone temperature heating setpoint at the zone thermostat. Limit adjustment from BAS temperature setpoint to +/- 3 deg F.

D. Display and/or control the following:
1. Space temperature.
2. Space temperature setpoint (occupied and unoccupied).
3. Fan status.
4. Heating system status.
5. Control valve position

1.13 ELECTRIC CABINET UNIT HEATER

A. Equipment Controlled: ECUH-1, ECUH-2, and ECUH-3

B. Cabinet unit heater shall start/stop the electric resistance coil and unit supply fan to maintain space heating setpoint. Cabinet unit heater shall be controlled by internal standalone tamperproof thermostat.

1.14 EXISTING HYDRONIC CABINET UNIT HEATER

A. Equipment Controlled: X-CUH

B. Cabinet unit heater shall start/stop unit supply fan to maintain space heating setpoint. Cabinet unit heater shall be controlled by standalone internal tamperproof thermostat.

1.15 SIDE STREAM FILTER SKID PACKAGE

A. Equipment Controlled: SSF-1

B. The BAS activates pump on the side stream filter skid package whenever the main building circulation pumps are activated or whenever the outdoor temperature is below 45 deg F (adjustable).

C. Filter Pressure Drop: Monitor side stream filter pressure drop gauges and alarm system when pressure drop exceeds high or low limit settings.

D. Operator Station: Control and/or display the following:

1. System graphic.
2. Side stream filter pressure drop
3. Side stream filter pressure drop alarms (high and low)
4. Side stream filter alarms
5. Pump status
6. Pump alarm

1.16 MECHANICAL ROOM UNIT HEATER, EXHAUST FAN, AND INTAKE DAMPER SEQUENCE

A. Equipment Controlled:
1. Unit Heater: X-UH (Mechanical Room)
2. Exhaust Fan: EF-6
3. Dampers: D-3 (Intake).

B. Heating mode:
1. BAS monitors space temperature. Wall mounted BAS thermostat cycles the unit heater fans (on/off) and operates the 2-position control valves (2-way or 3-way) as required to maintain space heating setpoint (adjustable). Lock out unit fans when heating system is off. Each unit heater and thermostat are to be tied to the BAS.
2. Lock out the exhaust fan (EF-3) and associated dampers (D-3) when the heating system is on.

C. Cooling mode:
1. BAS monitors space temperature. When space temperature rises above the temperature setpoint (adjustable), the intake damper (D-3) shall prove open and then start the exhaust fan (EF-3). If damper fails to open alarm BAS and EF-3 is to remain off. If supply fan fails alarm BAS and close intake damper. Exhaust fan (EF-3) to run as required to maintain space cooling setpoint. Exhaust fan (EF-3) to run for a minimum of 5 minutes (adjustable). Once space temperature and minimum run time is met, the Exhaust fan (EF-3) shall turn off and associated

intake damper (D-3) shall close. Lock out supply fans and damper when cooling system is off.

2. BAS to lock out unit heaters when cooling system is on.

D. Display and/or control the following:

1. Space temperature.
2. Heating space temperature setpoint.
3. Cooling space temperature setpoint (exhaust fan)
4. Unit heater status.
5. Unit heater alarm.
6. Heating system status.
7. Cooling system status.
8. Exhaust fan status.
9. Exhaust fan alarm.
10. Intake damper position.
11. Intake damper alarms.
12. Unit heater control valve position.

1.17 DEHUMIDIFIER SEQUENCE

A. Equipment Controlled: DEH-1 and DEH-2

B. Dehumidifier to be controlled by standalone unit controls and remote mounted programmable humidistat. BAS to monitor all dehumidifier controller points and capable of adjusting humidity setpoints and schedules.

C. Dehumidifier controller to control space humidity setpoints and space schedule (occupied and unoccupied). BAS to alarm if room exceeds high limit relative humidity setpoint (adjustable) for 5 minutes.

D. Display and/or control the following:

1. System graphic.
2. Humidifier status.
3. Humidifier alarm.
4. Space temperature.
5. Space RH.
6. Space RH setpoint.
7. High limit RH alarm status (adjustable).

1.18 DOMESTIC WATER HEATER CONTROL

A. Equipment Controlled: DWH-1, DWH-2, & P-3

B. Domestic Water Heater(s) and Pump Control: Contractor to connect new domestic water heater(s) and pump to boiler internal “Domestic Water Heater Prioritization” controls. Pump is to run on a call for domestic hot water. Monitor pump through current

sensing relays. If pump fails alarm BAS. The boiler internal “Domestic Water Heater Prioritization” controls modulate the 2-way CV as required to maintain domestic hot water heater storage tank water temperature setpoint 140 deg F (adjustable).

C. All pumps and domestic water heaters control points are to be tied to the BAS and be integrated on to the front-end graphics. All setpoints are to be adjustable from the BAS.

D. Operator Station: Control and/or display the following:

1. System graphic.
2. Pump status
3. Pump alarm
4. Domestic hot water storage temperature
5. Domestic hot water storage temperature setpoint
6. Heating hot water supply temperature
7. Heating hot water return temperature
8. Domestic hot water supply temperature
9. Domestic hot water return temperature
10. Control valve position
11. Emergency shut down status

1.19 TOILET EXHAUST FANS

A. Equipment Controlled: EF-1, EF-2, and EF-3

B. Exhaust fan is to run continuously during occupied hours. Schedules are to be set and controlled by BAS.

C. Monitor fan status with current sensing relay and alarm BAS if unit fails.

D. Display and/or control the following:

1. Each fan status.
2. Each fan failure alarm.
3. Occupied/Un-occupied schedule

1.20 MISCELLANEOUS EXHAUST FANS

A. Equipment Controlled: EF-4 & EF-5

B. Exhaust fan is to run continuously during occupied hours. Schedules are to be set and controlled by BAS.

C. Monitor fan status with current sensing relay and alarm BAS if unit fails.

D. Display and/or control the following:

1. Each fan status.
2. Each fan failure alarm.

3. Occupied/Un-occupied schedule

1.21 ODOR PURGE FANS

A. Equipment Controlled: EF-7/D-4, EF-8/D-5, & EF-9/D-6.

B. Exhaust fan is to be locally controlled by manufacturer provided time delay switch. Exhaust fan can also be manually enabled/disabled from the BAS front-end graphics. The intake damper shall prove open prior to starting the exhaust fan.

C. Monitor fan status with current sensing relay and alarm BAS if unit fails.

D. Display and/or control the following:

1. Exhaust fan status.
2. Exhaust fan alarm.
3. Exhaust fan enable/disable.
4. Intake damper position.
5. Intake damper alarms.

1.22 DIGITAL MIXING VALVE

A. Equipment Controlled: MV-1

B. Mixing valve is to be controlled by internal controller and have LONworks interface card installed. BAS system shall be able to monitor and adjust domestic hot water supply temperature.

C. Monitor fan status with current sensing relay and alarm BAS if unit fails.

D. Display and/or control the following:

1. System graphic.
2. Domestic hot water temperature
3. Domestic hot water temperature setpoint
4. Mixing valve position
5. Alarms

1.23 NEW SPLIT SYSTEM HEAT PUMP

A. Equipment Controlled: HP-1/AC-1

B. Heat pump split system to be controlled by manufacturer provided thermostat/controller as needed to maintain space temperature setpoint. Heat pump split system to provide heating/cooling as needed to maintain space temperature setpoint.

C. BAS to connect to heat pump split system to monitor and adjust occupied/unoccupied space temperature setpoints.

D. Monitor and/or control the following:

1. System graphic.
2. Space temperature setpoint
3. Space temperature
4. Split System Alarms

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 230993

SECTION 270500

DATA COMMUNICATION SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. Provide premise wiring for data and Net distribution, locations as indicated on the Drawings.

1.02 SUBMITTALS

A. Product data for each product indicated/specified.
   1. Cables.
   2. Faceplates.
   3. Uninterrupted Power Source.
   4. Racks.
   5. Fiber Interconnect Tray.
   6. Patch panels.
   7. Two Fiber Switches (both required) and Modules for each.
   8. Grounding Bar and Service Loop cable tray.

B. Field Test Report. Test Data is due to DMVA design department before substantial completion is reached. All data jacks and cable connections systems shall be certified Category 6.

C. As-Built drawings.

1.03 SYSTEM OVERVIEW

A. This section specifies the requirements for wire, cable, connections devices, installation, and testing for wiring systems to be used as signal pathways for high-speed data transmission.

1.04 QUALITY ASSURANCE

A. All cable shall be installed and terminated to meet 100-Base T standards as defied by EIA-TIA-568 standards.

B. The contractor shall be responsible for the most efficient routing of the cable in conduit. The cable route must avoid any electrical equipment, such as fluorescent lighting, transformers, etc. that could induce noise on the cable.

C. Codes and Standards
   1. IEEE Compliance - Comply with Std 241, "IEEE Recommended Practice for Electric Power Systems in Commercial Buildings" pertaining to communication systems.
   2. EIA Compliance - Comply with EIA Standards RS-453, 455, and 464 pertaining to installation of telephone systems.
   3. ANSI/ICEA S-80-576 (1988) Communication Wire and Cable for Wiring Premises.
   4. NFPA National Electrical Code.
   5. REA 345-52 Service Entrance and Station Protector Installations (PC-5A).

6. REA 345-78 Carbon Arrestor Assemblies for Use in Protectors
7. ANSI/T1A/EIA – 568-B.2-1 Transmission Performance Specifications for 4-Pair 100-ohm Category 6 Cabling.

PART 2 - PRODUCTS

2.01 CONDUIT, OUTLET BOXES, AND COVER

A. Provide boxes and conduit in accordance with Sections GENERAL ELECTRICAL REQUIREMENTS.
   1. Mount boxes flush in finish walls to match height of 120-volt receptacles, unless indicated otherwise.

2.02 TWISTED PAIR CABLE

A. All the voice and data locations shall be wired with unshielded twisted pair (UTP) cable that is category 6 rated and has a total of four (4) pair of copper conductors. The two data cables shall be separate cables. All the category 6 rated cable shall be plenum rated.

B. Data Cable Jacket Color: Cable jacket color shall be factory applied and continuous along the entire length of the cable. Colors as follows:
   1. Jacket color for the data cable shall be blue in color.
   2. Jacket color for the second data cable shall be blue in color.

C. The wiring code of the cable will follow the ANSI/TIA/EIT-T568B (AT&T), option B standards

Pair 1	Blue/White	Pin 4
	White/Blue	Pin 5
Pair 2	White/Orange	Pin 1
	Orange/White	Pin 2
Pair 3	White/Green	Pin 3
	Green/White	Pin 6
Pair 4	White/Brown	Pin 7
	Brown/White	Pin 8

2.03 CONNECTORS

A. All category 6 UTP cabling (Wall Jacks) shall be terminated into snap-in 110 type CAT 6 RJ-45 connectors and meet TIA/EIA-568-B2.1, Cabling Transmission Performance Specifications for 4-Pair 100-ohm Category 6 Cabling. Products from Hubbell are preferred, RJ-45 Model HXJ 6 OR-orange, HXJ 6BL-blue. A minimum of two data jacks will be provided at each customer interface point (voice/data outlet).
   1. The top data jack shall be blue in color.
   2. The bottom data jack shall be orange in color.

2.04 FACEPLATES

A. Faceplates shall be high impact 94V-O rated thermoplastic of the appropriate type. Each faceplate shall fit a single-gang box opening and hold two jacks in a vertical orientation. The jack layout and size of the faceplate shall be as follows:
   1. Faceplate size: single-gang box opening.

a. Jack orientation: Two jacks in vertical alignment next to two more jacks in vertical alignment.

B. Voice, Data faceplate color shall match the electrical device plate color. If the electrical device plate is metallic, then the voice and data faceplate shall be ivory in color.

2.05 CABLE AND FACEPLATE IDENTIFICATION

A. The finished installation shall have labeling provided at each end of each cable with a permanent wrap around tag that is 6" from the end of the cable. This label should not be discarded during the installation process.

B. All faceplates shall have each jack location identified with a permanent label that is neatly applied. This label will include the category of use, and the cable number (EX. To-001); coordinate labeling with DMVA telecommunications mechanic.

2.06 FIBER OPTIC DATA SWITCHES AND SWITCH MODULES

1. Provide and install two (2) new rack mounted fiber optic data switches. The new switches shall be: one Cisco C9200L-48P-4X 48-port switch & one Cisco Meraki Cloud Managed MS120 24-port switch and a Cisco LIC-MS120-24P 5 Year license. No approved equals, no refurbished, nor any substitutes. Switches must have Power Over Ethernet (POE+) capability.
2. Each switch shall be provided with two (2) single mode fiber optic switch modules as follows:
   a. Single mode SFP by Cisco, product # GLC-LH-SMD (SFP); no approved equals, no refurbished, nor any substitutes.

2.07 UNINTERRUPTED POWER SOURCE

A. Rack Mounted Liebert GXT4 1000VA UPS or approved equal.

2.08 RACK, INTERCONNECT TRAY, PATCH PANELS AND ADDITIONAL ITEMS:

A. RACK: Basis-of-Design, Hubbell, model #SF841924.
   1. 45U rack units, 12ga. steel: provides 2000 pounds of equipment support with tapped holes on both the front and rear surfaces of the mounting channels.
   2. EIA 19” rack which is lockable/reversible double-hinged wall bracket and allows the cabinet to swing away from the wall for rear access to equipment cabling.
      a. Front door: Solid steel, field-reversible (left or right) hinge, quarter-turnkey lock. Provide with 2 keys.
      b. Center section: Welded 14-gauge steel, steel solid top, hinged ventilated sides with provisions for future addition of fans, self-latching closure for connecting center section to wall section with
         1) self-alignment ramp to support center section to wall section, heavy duty hinge with quick-release self-retained hinge pins.
      c. Rear wall section: Welded 14-gauge steel with gland plates, cable tie-down for cable management, and solid steel back wall.
   3. EIA-310-D COMPLIANT, NEMA / EEMAC Type 1, & UL Listed 2416; Type 1.
   4. EIA equipment mounting dimensions: width-standard 19”, Height-12U, Depth-20.5”, Finish –RAL 9005 black.

5. The rack shall also have adjustable 12-gauge steel mounting rails, and square hole mounting which is RU marked from bottom to top and are tapped M6 Cage Nut holes.
6. MOUNT the rack angles (vertical service bars that the equipment connects to) 3.5” from the inside of the closing front door.

B. RACK: Basis-of-Design, Hubbell, model #HSQ4826.
1. 26U rack units, 14ga. steel: provides 400 pounds of equipment support with tapped holes on both the front and rear surfaces of the mounting channels.
2. EIA 19” rack which is lockable/reversible double-hinged wall bracket and allows the cabinet to swing away from the wall for rear access to equipment cabling.
    a. Front door: Solid steel, field-reversible (left or right) hinge, quarter-turnkey lock. Provide with 2 keys.
    b. Center section: Welded 14-gauge steel, steel solid top, hinged ventilated sides with provisions for future addition of fans, self-latching closure for connecting center section to wall section with
        1) self-alignment ramp to support center section to wall section, heavy duty hinge with quick-release self-retained hinge pins.
    c. Rear wall section: Welded 14-gauge steel with gland plates, cable tie-down for cable management, and solid steel back wall.
3. EIA-310-D COMPLIANT, NEMA / EEMAC Type 1, & UL Listed 2416; Type 1.
4. EIA equipment mounting dimensions: width-standard 19”, Height-12U, Depth-20.5”, Finish –RAL 9005 black.
5. The rack shall also have adjustable 12-gauge steel mounting rails, and square hole mounting which is RU marked from bottom to top and are tapped 12-24 holes.
6. MOUNT the rack angles (vertical service bars that the equipment connects to) 3.5” from the inside of the closing front door.

C. PATCH PANEL: Basis-of-Design: Hubbell P624 patch panels. Provide the quantity of patch panels to meet requirements of the project (from wall jack count) plus 25% future ports. Patch panel(s) shall have the following specifications.
1. Front access
2. Category 6E
3. T568B 24 port
4. 110 punch-down on rear of panels

D. FIBER OPTIC INTERCONNECT TRAY: Basis-of-Design: Hubbell Optichannel hinged Fiber Rack Mount #FPR048ST patch panels.
1. GROUNDING BUS
2. Provide a length of grounding bus as specified in Section 260526 GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS, paragraph 2.01, C. The grounding bus shall be installed directly below the Data Rack and grounded to the building’s electrical grounding system via a #2AWG grounding conductor.
3. BASKET CABLE TRAY

E. Manufacturers: Basis-of-Design: Cablofil Inc. Provide one 48” length of basket style cable tray and mount to the wall, centered 8” above the new voice/data rack. Loop all twisted-pair cables and place in this cable tray to store the slack cable.

F. Materials – Metal, suitable for indoors, and protected against corrosion by an electroplated zinc galvanizing, complying with ASTM B 633, Type 1, not less than 0.000472-inch thickness and meet the following requirement:
1. Basket Cable Trays – 18” wide by 4” deep.

2.09 FIBER-OPTIC CABLING:

A. Basis-of-Design Product – Subject to compliance with requirements, provide ”Draka F-DPLDB-AJ-24-ES-012-E3”or a comparable product by one of the following:
   1. Avaya Inc.
   2. Berk-Tek; an Alcatel Company.
   3. Draka
   4. Mohawk/CDT; a division of Belden CDT.
   5. Nordex/CDT; a Subsidiary of Cable Design Technologies.
   6. Optical Cable Corporation.
   7. Panduit Corp.
   8. Superior Essex; Superior Telecommunications Inc.

B. Cable shall be:
   1. Single Mode.
   2. Single Jacketed.
   3. Loose Tube.
   4. ITU-T - G.652.D.
   5. Fiber count: Provide the fiber count of 12.
   6. Color Codes: Conductor insulation is color coded in accordance with industry standards.
   7. Outer jacket: Plenum rated.

C. Cable Connecting Hardware:
   1. Comply with TIA/EIA-568-B.3. Terminate with quick-connect, simplex- and duplex-Type LC couplers. Insertion loss shall be not more than 0.7 dB.

PART 3 – EXECUTION

3.01 INSTALLATION

A. All customer interface (data outlet) boxes shall be 4”x4” boxes with a 2-gang plaster ring.

B. Install cabling concealed in ceiling and walls. Cabling to be parallel and perpendicular to surfaces and follow surface contours. Secure and support cables by straps, staples, or similar fittings so designed and installed to avoid damage to cables. Secure cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, or fitting.

C. Install cabling using techniques, practices, and methods that are consistent with categories and RG type rating at components and that ensure category 6 and RG type performance of completed and linked signal path, end to end.

D. Install cables without damaging conductor’s shields or jackets. A minimum cable installation bending radius shall be observed. Minimum bend radius is defined as a radius of curvature no less than 4 times the outside diameter of the cable.

E. The contractor shall be responsible for the most efficient routing of the cable in conduit. The cable route must avoid any electrical equipment, such as fluorescent lighting, transformers, etc. that could induct noise on the cable.

F. Each wall jack location shall have a single, continuous two (2) 4-pair cable pulled to it from the source location. No splices between the patch panel and the wall jack will be accepted. A minimum of 12- inches of excess cable will be left after termination, coiled neatly inside the

4”x4” wall box, and the minimum bend radius for the coil will be observed. A service loop of no less than six feet of excess cable will be neatly coiled above the equipment rack while ensuring that minimum bend radius is observed.

G. 100% of the category 6 (UTP) cabling will be installed and tested in accordance with T1A/EIA-568-B2.1 Clause 11, Cabling Transmission Performance and Test Requirements. The contractor shall use an electronic testing device to test each cable for the following: (Submit printed output from this test device to DMVA for review.)
   1. Attenuation
   2. Impedance
   3. Capacity
   4. Resistance
   5. Length
   6. dB loss
   7. Pin Assignments
   8. Continuity
   9. Polarity
   10. Near end cross talk

H. Scan and test each cable using industry standard equipment for items 1 – 10 above. The results shall be produced in electronic copies and provided to the DOIM/DMVA Network Engineer in MS Excel format.

I. Fiber-Optic Cable Tests:
   1. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
   2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
   3. Link End-to-End Attenuation Tests:
      a. Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in 1 direction according to TIA/EIA-526-14-A, Method B, One Reference Jumper.
      b. Attenuation test results for horizontal links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-B.1

J. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDM, or transferred from the instrument to the computer, saved as text files, and submitted. Electronic submittals are sufficient.

K. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

L. Retest and inspect cabling to determine compliance of replaced or additional work with specified requirements.

3.02 CABLE IDENTIFICATION

A. Common Areas & Office Marking Standard:
   1. The connection boxes placed on walls or in the bases of cubical furniture shall be labeled clockwise from the main entrance door A1-1, B1-1, A1-2, B1-2, etc around the outside

wall, then to interior walls and cubical connections until all interfaces are designated. A1/B1 specifies the patch panel number. The -# specifies the patch panel port number. Top, or blue data jacks, will be labeled as the A drops. Bottom, or orange data jacks, will be labeled as the B drops.

2. Blue data jacks, (A labeled jacks), will be terminated in patch panels and labeled accordingly at the rack. Orange data jacks, (B labeled jacks), will be terminated in SEPARATE patch panels and labeled accordingly at the rack. The end state is to have A drops and B drops on separate physical patch panels.
3. Patch panels will be labeled as PP A-1 and PP B-1. When there are more than 24 data drop locations, additional patch panels will be added and labeled PP A-2/PP B-2 and so on. Data drops will reflect this as A2-1, B2-1. This marking would specify Patch Panel A2 Drop #1, Patch Panel B2 Drop #1.

END OF SECTION 270500

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