

SECTION 098413 - FIXED SOUND-ABSORPTIVE AND TACKABLE PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes:

1. Stretched fabric wall panels
2. Stretched fabric ceiling panels.
3. Framework mounting extrusions
4. Core materials
5. Fabric facing
6. Fabric treatments

B. Related Sections include the following:

1. Division 09 Section "Gypsum Veneer Plastering" for preparation of panel attachment.
2. Division 09 Section "Interior Painting" for preparation of panel attachment.

1.2 REFERENCES

A. American Society for Testing and Materials:

1. ASTM C423 Test Method for Sound Absorption and Sound Absorption Coefficients by Reverberation Room Method
2. ASTM E84 Test Methods for Surface Burning Characteristics of Building Materials
3. ASTM E2573 Specimen Preparation and Mounting of Site-Fabricated Stretch Systems to Assess Surface Building Characteristics

B. United States Green Building Council: www.USGBC.org

1. LEED Building Versions
 - a. LEED New Construction 2009

1.3 DEFINITIONS

- A. NRC: Noise reduction coefficient.

1.4 SYSTEM DESCRIPTION

A. Design Requirements:

1. Stretched fabric panel system shall consist of continuous perimeter and butt seam mounting extrusions, site-fabricated, and applied directly to substrate.

2. Facing fabric shall be stretched over core materials, leaving fabric floating above core surface. Fabric facing application shall not utilize adhesives, nails, tacks, screws, or tapes. Nails, tacks, screws or similar items shall not be installed through facing fabric to secure panel.
3. System shall allow for removal and replacement of fabric facing from individual panels. Removal of fabric shall provide access to surface behind fabric, without dismantling, removal, or replacement of mounting extrusions or core material.
4. Hinged, self-locking (snap-lock) type mounting extrusions and extrusions using tape to adhere fabrics do not satisfy intent of this specification.
5. Prefabricated panels do not satisfy intent of this specification.
6. Two - piece mounting extrusions (snap-together) do not satisfy intent of this specification.
7. Wood ground systems and non-fire rated wood ground assemblies do not satisfy intent of this specification

1.5 SUBMITTALS

- A. Product Data: For each type of panel edge, core material, and mounting indicated.
- B. Shop Drawings: For acoustical wall panels. Include mounting devices and details; details at panel head, base, joints, and corners; and details at ceiling, floor base, and wall intersections. Include elevations showing panel sizes and direction of fabric weave and pattern matching. Indicate panel edge and core materials.
- C. Coordination Drawings: Show intersections with wall base, shelves, doors, electrical outlets and switches, and other adjacent work.
- D. Samples for Initial Selection: For each type of fabric facing material for each type of panel from manufacturer's full range.
- E. Samples:
 1. Submit 2 samples as follows:
 - a. Each type mounting extrusion
 - b. Each type fabric facing
 - c. Each type core material
 2. Sample Size: 4" x 4" or 4" in length as appropriate to material
 3. Submit 2 samples of stretched fabric panel system mounted on a substrate, demonstrating typical joining conditions. Sample size shall be large enough to demonstrate typical and special conditions, but not less than 9" x 9".
 4. At a location designated by Architect, construct a full size sample panel incorporating fabrics, seaming and layout as required by Architect.
- F. LEED SUBMITTALS
 1. Submit LEED credit calculations and required paperwork and certification items for review by LEED committee. Version of LEED project required.
 2. Materials and Resources
 - a. Credit 4 Recycled Content
 - b. Credit 6 Rapidly Renewable Materials
 3. Indoor Environmental Quality

a. Credit 4.1 Low-emitting Materials, Adhesives and Sealants

G. CONTRACT CLOSE-OUT SUBMITTALS:

1. Submit procedures to be followed in cleaning and maintaining stretched fabric panels. Include a copy of instruction in Operation and Maintenance Data Manual.

1.6 PROJECT CONDITIONS

- A. Field Measurements: Verify locations of acoustical wall panels by field measurements before fabrication and indicate measurements on Shop Drawings.

1.7 SEQUENCING AND SCHEDULING

- A. Schedule installation of stretched fabric system as late as possible in sequence of construction schedule to reduce damage.
 1. Do not install stretched fabric system until space is enclosed, weather tight and conditioned.
 2. Under no circumstances shall installation begin prior to completion of abutting grid ceiling installation.
 3. No wet work shall remain with exception of touchup.

1.8 QUALITY ASSURANCE

- A. Manufacturer's Instructions:
 1. Submit manufacturer's summary of installation procedures which shall be basis for accepting or rejecting actual installation procedures.
- B. Test Reports: This fire code section is considered MANDATORY. Stretched fabric panel systems or fabrics not in compliance should be rejected.
 1. Submit complete, unedited test reports for stretched fabric panel system prepared by an independent testing laboratory that is IAS Certified indicating full compliance with both acoustical and fire resistance performance requirements.
 - a. Fire ratings shall be for a complete assembly, including perimeter and longitudinal butt joint framing extrusions, core material, and fabric covering as required by ASTM E2573-07 Specimen Preparation and Mounting of Site Fabricated Stretch Systems to Assess Surface Burning Characteristics.
 - b. Systems must be certified under ASTM E84 and Class must be compliant with placement in the building:
 - a) Class A - Flame Spread Index (0-25)
 2. Submit complete test reports for fabric covering prepared by an independent testing laboratory that is IAS Certified indicating compliance with specified fire resistance performance requirements ASTM E84 Unadhered Method.

C. Certificates:

1. Provide certification from manufacturer of stretched fabric panel system attesting to their product's compliance with specified requirements including mandatory fire performance characteristics under ASTM E84 and further compliance with ASTM E2573-07.
2. Provide certification that specialized equipment as may be required by manufacturer for proper installation of system shall be utilized.
3. Provide certification that technicians utilized for installation have been trained or qualified by manufacturer.

D. Single Source Responsibility

1. To greatest extent possible, materials shall be products of a single manufacturer or items standard with manufacturer of stretched fabric panel system.
 - a. Provide secondary materials which are produced, or are specifically recommended by stretched fabric panel system manufacturer to ensure compatibility.

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of acoustical wall panels that fail in performance, materials, or workmanship within specified warranty period.
1. Failure in performance includes, but is not limited to, acoustical performance.
 2. Failures in materials include, but are not limited to, fabric sagging, distorting, or releasing from panel edge; or warping of core.
 3. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CORE MATERIALS

- A. Glass-Fiber Board: ASTM C 612, Type IA or Types IA and IB; density as specified, unfaced, dimensionally stable, molded rigid board, with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.
- B. Mineral-Fiber Board: Maximum flame-spread and smoke-developed indexes of 15 and 5, respectively.
- C. Tackable, Impact-Resistant, High-Density Face Layer: layer of cork laminated to face of core.

2.2 BACK-MOUNTED, EDGE-REINFORCED ACOUSTICAL WALL PANELS WITH GLASS-FIBER BOARD CORE

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Basis of Design: "Novawall", site-fabricated stretched fabric panel system consisting of continuous perimeter and midwall mounting channels applied directly to substrate, or comparable product by one of the following:
 - a. Kinetics Noise Control <http://www.kineticsnoise.com>.
 - b. Conwed.
 - c. USG Corporation.
- C. Stretched Fabric Panel System:
 1. Panel Size and Thickness: As indicated on Drawings.
- D. Framework: Extruded polymer
- E. Edge Profile: 1" EcoTrack PVC_{free} – Square Classic Profile
- F. Midseam Profile: 1" Square – ¼" Reveal
- G. Acoustic Core Material: Semi-rigid fiberglass board
 1. Density: 6 pcf
 2. Thickness: 1"
 3. Noise Reduction Coefficient; determined by ASTM C423 Type A Mounting
 - a. 1" thickness: .80 minimum
- H. Tackable Core Material: Mineral fiberboard
 1. Density: 24 pcf
 - a. Thickness: 1"
- I. Fire Resistance: Mandatory compliance of ASTM E2573-07 under ASTM E84.
 1. Complete panel assembly, including perimeter framework, longitudinal midwall support, mounting devices, core, and fabric shall have a certificate from an independent IAS Certified testing facility indicating compliance for Flame Spread and Smoke Developed under ASTM E84 and further to meet mandatory mounting requirements of ASTM E2573-07.
 - a. Flame Spread: Class A(0 -25)
 - b. Smoke Developed: Not to exceed 450
- J. Acoustic Panel Fabric:
 1. Source: Fabric from same dye lot; color and pattern as selected by Architect from manufacturer's full range.
 2. Fabric Content: Fiber contents which have a polyester content exceeding 10% to resist yarn cycling with normal changes in relative humidity.
 - a. 100% polyester – ASTM 84E
 - b. Manufacturer: Gilford
 3. Treatments of Backings: As recommended by manufacturer.

2.3 FABRICATION

A. Fabric Treatment:

1. Provide fabric with single pass, upholstery grade acrylic backing when required for proper installation. Other backings shall not be used without written approval from stretched fabric panel system manufacturer.
2. Provide liner when required to ensure uniform appearance of face fabric.
3. Fabric facings not treated when manufactured shall be treated with Teflon guard protective finish to enhance fabric's stain resistance.]
4. Shop applies fabric treatments without affecting flame retardancy requirements, appearance, color, or hand of fabric.]

B. Fabric Flame Treatment: If a fabric is considered for panel application and requires a flame treatment application;

1. The fabric should be evaluated by an Authorized Distributor, Certified Installer or Novawall® representative for its fiber content and appropriateness for panel application.
2. It is mandatory that it also be tested under ASTM E84 Unadhered Method by an independent IAS Certified facility, after flame treatment.
3. Documentation by certification must be provided by the IAS Certified testing facility indicating, the textile or fabric tested, by Manufacturer Name, Product Style Name and/or Number and must include flame treatment type applied by treatment facility.
4. A copy of the original certificate from the IAS Certified testing facility must be provided to the Authorized Distributor for project record documents and for local Fire Marshall review.

C. Dimensional Tolerances of Finished Units: Plus or minus 1/16 inch for the following:

1. Thickness.
2. Edge straightness.
3. Overall length and width.
4. Squareness from corner to corner.
5. Chords, radii, and diameters.

D. Back-Mounting Devices: Concealed on backside of panel, recommended to support weight of panel, with base-support bracket system where recommended by manufacturer for additional support of panels, and as follows:

1. As recommended by manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Site Verification of Conditions:

1. Examine substrate and spaces in which work is to be performed.
2. Do not begin installation until:
 - a. Space has been enclosed and is weather-tight

- b. Wet work has been completed and is dry
 - c. Painting is completed and wall base and floor covering is installed
 - d. Adjacent work of other trades such as woodwork, ceilings, wall coverings, etc. have been completed
3. Drywall surfaces shall be taped, bedded, sanded, and primed. Penetrations shall be sealed against air and moisture leakage through wall.
 4. Do not proceed with installation until unsatisfactory conditions have been corrected. Beginning of installation indicates acceptance of existing substrate conditions.

3.2 INSTALLATION

A. General Requirements:

1. Panel edges shall abut adjacent finishes or surfaces or to conform to adjacent joint conditions without reveals or gaps unless required by design.
2. Visible surfaces shall be fully covered and free from wrinkles, sags, blisters, and foreign matter.
3. Panel joints shall be tight, straight, true, plumb, and in proper relation to building lines without ripples, waviness, and "hourglass" effects.
4. Seaming of fabric by sewing shall not be allowed.

B. Framework: 1. Install framework in strict compliance with shop drawings and manufacturer's instructions.

1. Framework shall be installed around perimeter of each panel area. To greatest extent possible, install members in continuous lengths.
2. Install framework shimmed, plumbed, and scribed to align with adjacent surfaces. Attach in a manner to prevent sagging or moving out of position after fabric has been stretched tightly. Framework members shall not telescope through face of fabric.
3. Secure framework to wall surface using pneumatically driven 18 gauge staples with a diverging head to form divergent-tine wall anchors spaced at 2-3" on center.
4. Provide framework flush with face of panel around outlet boxes, duplex receptacles, thermostats, etc., which may occur within fabric panel area.

C. Core Materials:

1. Materials shall be installed in a continuous manner, flush and level with framework. Material shall be tight to the framework at all points.
2. Materials shall be installed using a suitable method of mechanical fastening. Adhesives are not to be acceptable for use when installing core materials to substrate.

D. Fabric Facing:

1. Cut fabric from each roll maintaining sequence of drops and matching direction of weave for sequential and uniform installation.
2. Install fabric with warp and weft threads plumb, level, and true. Patterns, textures, and grain of fabric shall be aligned and matched at seams. Throughout entire seam, join wall panels without distortion to geometry of fabric or pattern.
3. Fabric shall be stretched, re-stretched, and tensioned over framework and left to atmospherically cure for a minimum of 24 hours between stretchings until sufficiently taught to avoid sagging under varying year-round temperature and humidity conditions.

4. Installed fabric shall be stretched taut so as not to puddle or dent when touched or leaned upon. Fabric shall be self-healing when pushed, punched, or hit, and shall revert back to original finished condition.
5. Fabric shall be applied securely to grounds using a hand tool appropriate for joint condition and nature of fabric. No nailing, tacking, stapling, adhesive taping, or gluing of fabric shall be permitted. Ensure that fabric surface is free of wrinkles and that weave is plumb and straight and properly aligned horizontally and vertically.
Fabric shall be installed as monolithic stretched fabric in continuous runs without reveals

E. Site Tolerances:

1. Maximum variation of panels from true location shall be 1/8".
2. Maximum variation of surfaces intended to be flush shall be 1/16".
3. Maximum variation of reveal width shall be 1.

3.3 CLEANING

- A. Clip loose threads; remove pills and extraneous materials.
- B. Clean panels with fabric facing, on completion of installation, to remove dust and other foreign materials according to manufacturer's written instructions.

3.4 PROTECTION

- A. Replace acoustical wall panels that cannot be cleaned and repaired, in a manner approved by Professional, before time of Substantial Completion.

END OF SECTION 098413

SECTION 104310 - SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes: Interior non-illuminated directional, control, and information surface mounted signage. Scope of work includes installation.

1.2 REFERENCES

- A. Standards of the following as referenced:

- 1. American National Standards Institute (ANSI).

- B. Industry Standards:

- 1. Department of Justice, Office of the Attorney General, "American with Disabilities Act", Public Law 101-336, (ADA).
- 2. ANSI A117.1: Providing Accessibility and Usability for Physically Handicap People, 1992 edition.
- 3. Federal Register Part III, Department of Justice, Office of the Attorney General, 28 CFR Part 36: Nondiscrimination on the Basis of Disability by Public Accommodations and in Commercial Facilities, Final Rule, July 26, 1991.
- 4. Federal Register Part II, Architectural and Transportation Barriers Compliance Board, 36 CFR Part 1191: Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Amendment to Final Guidelines, September 6, 1991.

1.3 DEFINITIONS

- A. Terms:

- 1. Braille: Grade 2 Braille including 189 part-word or whole word contractions in addition to Grade 1 Braille 63 characters. Tactile is required whenever Braille is required; see SYSTEM DESCRIPTION Article below.
- 2. Non-tactile: Letters and numbers on signs with width-to-height ratio between 3:5 and 1:1 and stroke width ratio between 1:5 and 1:10 using upper case "X" to calculate ratios. Use typestyles with medium height; upper and lower case lettering is permitted; serif typestyles are permitted. See SYSTEM DESCRIPTION Article below.
- 3. Symbols: Symbol itself is not required to be tactile but equivalent verbal description is required both in tactile letters and Braille.
- 4. Tactile: 1/32" raised capital letters without serifs at least 5/8" heights and not more than 2" height based on upper case "X". Braille is required whenever tactile is required; see SYSTEM DESCRIPTION Article below.

1.4 SYSTEM DESCRIPTION

- A. Signage under this section is intended to include items for identification, direction, control, and information of building where installed as complete integrated system from a single manufacturer.
- B. ADA Design Requirements:
1. Signage requiring tactile graphics:
 - a. Wall mounted signs designating permanent rooms and spaces such as, room numbers and restroom, department, office, and fire exit identifications.
 - b. Individually applied characters are prohibited.
 2. Signage not requiring tactile graphics but require compliance to other ADA requirements: All other signs providing direction to or information about function of space such as, directional signs (signs with arrow), information signs (operating hours, policies, etc.), regulatory signs (no smoking, do not enter), and ceiling and projected wall mount signs.
 3. Excluded signage:
 - a. Exterior signs.
 - b. Building directories.
 - c. Menus.
 - d. Temporary signs, include personnel signs and tenant identification, suite numbers are not considered temporary.
- C. ADA Performance Requirements:
1. Tactile graphics signs mounting requirements:
 - a. Single Doors: Mount 60" to sign centerline above finish floor and on wall adjacent to latch side of door.
 - b. Openings: Mount 60" to sign centerline above finish floor adjacent opening.
 - c. No wall space adjacent latch side of door, opening, or double doors: Mount 60" to sign centerline above finish floor on nearest adjacent wall.

1.5 SUBMITTALS

- A. Product Data:
1. Manufacturer's signed statement regarding compliance with QUALITY ASSURANCE Article.
 2. Manufacturer's product literature indicating units and designs selected.
 3. Evidence of manufacturer's computerized data retrieval program for tracking of Project for sign typography, message strip requirements, and other pertinent data from schedule input to final computerized typography on finished product.
- B. Shop Drawings:
1. Indicate materials, sizes, configurations, and applicable substrate mountings.
 2. Typography sample for copy.
 3. Signage schedule complete with location of each sign and required copy; include Typical First Floor plans.

4. Artwork for special graphics.
5. Provide typical shop drawing for all other sign types.

C. Samples:

1. Full size samples for one of each sign type.
2. Samples will be returned for use in Project, if acceptable.

D. Contract Closeout:

1. Furnish appropriate checklist for aiding in reordering after Date of Substantial Completion. Maintain computer schedule program for five years for ordering new signage required by Owner.
2. Maintenance data and cleaning requirements for exterior surfaces.

1.6 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer:
 - a. Work required under this section from manufacturers regularly engaged in work of this magnitude and scope for minimum of five years.
 - b. Maintain computer link between schedule input and computerized typography production.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Acceptance at Site: Coordinate delivery of work to Project site under this section for immediate installation.

1.8 SEQUENCING AND SCHEDULING

- A. Schedule system installation after related finishes have been completed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

2.2 PANEL SIGNS

- A. **General:** Provide panel signs that comply with requirements indicated for materials, thicknesses, finishes, colors, designs, shapes, sizes, and details of construction.
1. Allenite Signs; Allen Marking Products, Inc.
 2. American Graphics Inc.
 3. Andco Industries Corp.
 4. APCO Graphics, Inc. (Basis of Design)
 5. ASI Sign Systems, Inc.
 6. Best Manufacturing Co.
 7. Grimco, Inc.
 8. Innerface Sign Systems, Inc.
 9. Kaltech Industries Group, Inc.
 10. Mills Manufacturing, Inc.
 11. Mohawk Sign Systems.
 12. Seton Identification Products.
 13. Signature Signs, Inc.
 14. Supersine Company (The).
- B. **Phenolic-Backed Photopolymer Sheet, for portion of signs with braille and raised letters:** Provide light-sensitive, water-wash photopolymer face layer bonded to a phenolic base layer to produce a composite sheet with overall, face-layer, and base-layer thicknesses, respectively, of 0.120 inch (3 mm), 0.040 inch (1 mm), and 0.080 inch (2 mm), and a Type D Shore durometer hardness of 80.
1. **Available Product:** Subject to compliance with requirements, a product that may be incorporated into Work includes, but is not limited to, "Jet-288" Phenolic Interior Signage" by JetUSA.
- C. **Unframed Panel Signs:** Fabricate signs with edges mechanically and smoothly finished to comply with the following requirements:
1. **Edge Condition:** Square cut.
- D. **Laminated Panels:** Permanently laminate face panels to backing sheets of material; use manufacturer's standard process.
- E. **Graphic Content and Style:** Provide sign copy that complies with requirements indicated on Drawings for size, style, spacing, content, mounting height and location, material, finishes, and colors of signage. Drawing showing sign locations and color selection to be provided by Architect.
- F. **Tactile and Braille Copy:** Manufacturer's standard process for producing copy complying with ADA Accessibility Guidelines and ICC/ANSI A117.1. Text shall be accompanied by Grade 2 braille. Produce precisely formed characters with square cut edges free from burrs and cut marks.
1. **Panel Material:** Photopolymer.
 2. **Raised-Copy Thickness:** Not less than 1/32 inch (0.8 mm).
- G. **Colored Coatings for Acrylic Sheet:** For copy and background colors, provide Pantone Matching System (PMS) colored coatings, including inks and paints, that are recommended by acrylic manufacturers for optimum adherence to acrylic surface and are nonfading for application intended.

2.3 ACCESSORIES

- A. Mounting Methods: Use 3M double-sided foam tape.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Locate signs and accessories where indicated, using mounting methods of types described and in compliance with manufacturer's written instructions. Floor plans showing location of all signs shall be provided by Architect.
1. Install signs level, plumb, and at heights indicated, with sign surfaces free from distortion and other defects in appearance.
 2. Interior Wall Signs: Install signs on walls adjacent to latch side of door where applicable. Where not indicated or possible, such as double doors, install signs on nearest adjacent walls. Locate to allow approach within 3 inches (75 mm) of sign without encountering protruding objects or standing within swing of door.
- B. Wall-Mounted Panel Signs: Attach panel signs to wall surfaces using methods indicated below:
1. Vinyl-Tape Mounting: Use double-sided foam tape to mount signs to smooth, nonporous surfaces. Do not use this method for vinyl-covered or rough surfaces.
 2. Where panel signs are scheduled or indicated to be mounted on glass, provide matching plate on opposite side of glass to conceal mounting materials.

END OF SECTION 10431

SECTION 230900 – INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. All work of this Division shall be coordinated and provided by the single Building Management System (BMS) Sub-Contractor.
- B. The work of this Division shall be scheduled, coordinated, and interfaced with the associated work of other trades. Reference the Division 23 Sections for details.
- C. The work of this Division shall be as required by the Specifications, Drawings, Point Schedules and Division 230993.
- D. If the BMS Contractor believes there are conflicts or missing information in the project documents, the Contractor shall promptly request clarification and instruction from the design team.

1.2 BMS DESCRIPTION

- A. It is the intent of this project to provide a web accessible, interoperable Building Management System (BMS) based on server/thin client architecture, with support for multiple communication protocols, and designed around the open standards of web technology. In addition to other capabilities described hereinafter, the BMS shall include full programmability of all connected nodes (controllers provided by the ATC Contractor) via the web for an authorized user. The BMS shall also include implemented override capability of all controller outputs (for controllers provided by the ATC Contractor) via the web for an authorized user. An authorized user shall also be able to create/edit graphic screens, trends and alarms without the need for any additional hardware and/or software. Ethernet drop for the personal computer workstation shall be provided by the Electrical Contractor.
- B. Devices residing on the automation network located in equipment rooms and similar shall be fully IT compatible devices that mount and communicate directly on any IT infrastructure in the facility. ATC Contractor shall be responsible for providing all labor and materials for Ethernet infrastructure required for network level ATC Controllers. This shall consist of control systems for:

- 1. Summer Boiler
- 2. Chilled Water System
- 3. Steam and Hot Water Systems
- 4. Air Handling Units (Variable Volume)
- 5. Energy Recovery Air Handling Units
- 6. Hot and Chilled Water Pumps
- 7. VAV Boxes with Hydronic Heat
- 8. Exhaust Fans
- 9. Radiant Panels
- 10. Stairwell Pressurization Fans
- 11. Split System Air Conditioning Units
- 12. Cabinet/Horizontal unit heaters
- 13. Fan Coil Units
- 14. Remote Condensing Units
- 15. Motor Operated Dampers.
- 16. Boiler Emergency Shut Down System
- 17. All other Miscellaneous HVAC Equipment
- 18. Graphical Programmer
- 19. Graphical User Interface (GUI)
- 20. Portable Operator's Terminal (POT)

21. Workstation Server Hardware Station

- C. All points of user interface shall be on standard PCs that do not require the purchase of any special software from the BMS manufacturer for use as a building operations terminal. The primary point of interface on these PCs will be a standard Web Browser.
- D. A Server shall be used for the purpose of providing a location for extensive archiving of system configuration data, and historical data such as trend data and operator transactions. All data stored will be through the use of a standard data base platform: Microsoft Data Engine (MSDE).
- E. The work of the single BMS Sub-Contractor shall be as defined individually and collectively in all Sections of this Division specification together with the associated Point Sheets and Drawings, Division 230993 and the associated interfacing work as referenced in the related documents.
- F. The BMS work shall consist of the provision of all labor, materials, tools, equipment, software, software licenses, software configurations and database entries, interfaces, wiring, tubing, installation, labeling, engineering, calibration, documentation, samples, submittals, testing, commissioning, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, temporary protection, cleaning, cutting and patching, warranties, services, and items, even though these may not be specifically mentioned in these Division documents which are required for the complete, fully functional and commissioned BMS.
- G. Provide a complete, neat and workmanlike installation. Use only manufacturer employees who are skilled, experienced, trained, and familiar with the specific equipment, software, standards and configurations to be provided for this Project.
- H. Manage and coordinate the BMS work in a timely manner in consideration of the Project schedules. Coordinate with the associated work of other trades so as to not impede or delay the work of associated trades.
- I. The BMS as provided shall incorporate, at minimum, the following integrated features, functions and services:
 - 1. Operator information, alarm management and control functions.
 - 2. Enterprise-level information and control access.
 - 3. Information management including monitoring, transmission, archiving, retrieval, and reporting functions.
 - 4. Diagnostic monitoring and reporting of BMS functions.
 - 5. Offsite monitoring and management access.
 - 6. Energy management
 - 7. Standard applications for terminal HVAC systems.
 - 8. Indoor Air Quality monitoring and control
- J. All controllers (provided by the ATC Contractor) shall be fully field programmable by the owner to allow for field customization, both now and in the future, to meet the owner's exact control strategy requirements and address ongoing changes in those requirements. In addition, an authorized user shall also be able to create/edit graphic screens, trends and alarms, upload/download Field Equipment Controllers, Input/Output Modules Variable Air Volume Box Controller and Networked Thermostat

Controller databases, monitor all BACnet Objects including but not limited to Analog and Digital Inputs/Outputs/Values, monitor and override all controller physical input/output points, and edit controller resident time schedules, all without the need for any additional vendor interaction. All hardware and software tools and accessories required to provide the owner with these capabilities shall be furnished as part of this project. **NO EXCEPTIONS**

1.3 QUALITY ASSURANCE

A. General

1. The Building Management System Sub-Contractor shall be the primary manufacturer-owned branch office that is regularly engaged in the engineering, programming, installation and service of total integrated Building Management Systems. Throughout this specification, any reference to "ATC Contractor", "BAS Control Contractor", or "Controls Contractor" shall be interpreted as referring to the Building Management System Sub-Contractor.
2. The term "manufacturer" when used to identify an automatic temperature control sub-contractor/supplier, shall mean the complete system of building energy management. Components of the completed system shall include but not being limited to, hardware equipment, engineering, wiring, installation, sequence of operations, network architecture, commissioning, training, software programming and warranty.
3. The BMS Sub-Contractor shall be a recognized national manufacturer, installer and service provider of BMS.
4. Franchised dealers, or HVAC Contractors installing their own controls will not be accepted. **NO EXCEPTIONS.**
5. The BMS Sub-Contractor shall have a branch facility within a 100-mile radius of the job site supplying complete maintenance and support services on a 24 hour, 7-day-a-week basis.
6. As evidence and assurance of the contractor's ability to support the Owner's system with service and parts, the contractor must have been in the BMS business for at least the last ten (10) years and have successfully completed projects with a total value of at least 10 times the value of this contract in each of the preceding five years.
7. The Building Management System architecture shall consist of the products of a manufacturer regularly engaged in the production of Building Management Systems, and shall be the manufacturer's latest standard of design at the time of bid.

B. Workplace Safety and Hazardous Materials

1. Provide a safety program in compliance with the Contract Documents.
2. The BMS Contractor shall have a corporately certified comprehensive Safety Certification Manual and a designated Safety Supervisor for the Project.
3. The Contractor and its employees and subtrades comply with federal, state and local safety regulations.
4. The Contractor shall ensure that all subcontractors and employees have written safety programs in place that covers their scope of work, and that their employees receive the training required by the OSHA having jurisdiction for at least each topic listed in the Safety Certification Manual.

5. Hazards created by the Contractor or its subcontractors shall be eliminated before any further work proceeds.
6. Hazards observed but not created by the Contractor or its subcontractors shall be reported to either the General Contractor or the Owner within the same day. The Contractor shall be required to avoid the hazard area until the hazard has been eliminated.
7. The Contractor shall sign and date a safety certification form prior to any work being performed, stating that the Contractors' company is in full compliance with the Project safety requirements.
8. The Contractor's safety program shall include written policy and arrangements for the handling, storage and management of all hazardous materials to be used in the work in compliance with the requirements of the Authority Having Jurisdiction (AHJ) at the Project site.
9. The Contractor's employees and subcontractor's staff shall have received training as applicable in the use of hazardous materials and shall govern their actions accordingly.

C. Quality Management Program

1. Designate a competent and experienced employee to provide BMS Project Management. The designated Project Manger shall be empowered to make technical, scheduling and related decisions on behalf of the BMS Contractor. At minimum, the Project Manager shall:
 - a. Manage the scheduling of the work to ensure that adequate materials, labor and other resources are available as needed.
 - b. Manage the financial aspects of the BMS Contract.
 - c. Coordinate as necessary with other trades.
 - d. Be responsible for the work and actions of the BMS workforce on site.

1.4 REFERENCES

A. All work shall conform to the following Codes and Standards, as applicable:

1. National Fire Protection Association (NFPA) Standards.
2. National Electric Code (NEC) and applicable local Electric Code.
3. Underwriters Laboratories (UL) listing and labels.
4. UL 864 UUKL Smoke Control
5. UL 268 Smoke Detectors.
6. UL 916 Energy Management
7. NFPA 70 - National Electrical Code.
8. NFPA 90A - Standard For The Installation Of Air Conditioning And Ventilating Systems.
9. American National Standards Institute (ANSI).
10. National Electric Manufacturer's Association (NEMA).
11. American Society of Mechanical Engineers (ASME).
12. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) and ASHRAE 62 IAQ as applicable.
13. Air Movement and Control Association (AMCA).
14. Institute of Electrical and Electronic Engineers (IEEE).
15. American Standard Code for Information Interchange (ASCII).
16. Electronics Industries Association (EIA).
17. Occupational Safety and Health Administration (OSHA).
18. American Society for Testing and Materials (ASTM).

19. Federal Communications Commission (FCC) including Part 15, Radio Frequency Devices.
20. Americans Disability Act (ADA)
21. ANSI/ASHRAE Standard 195-2004 (BACnet)

- B. In the case of conflicts or discrepancies, the more stringent regulation shall apply.
- C. All work shall meet the approval of the Authorities Having Jurisdiction at the project site.

1.5 SUBMITTALS

A. Shop Drawings, Product Data, and Samples

1. The BMS contractor shall submit a list of all shop drawings with submittals dates within 60 days of contract award.
2. Equipment and systems requiring approval of local authorities must comply with such regulations and be approved. Filing shall be at the expense of the BMS Contractor where filing is necessary. Provide a copy of all related correspondence and permits to the Owner.
3. Prepare an index of all submittals and shop drawings for the installation. Index shall include a shop drawing identification number, Contract Documents reference and item description.
4. The BMS Contractor shall correct any errors or omissions noted in the first review.
5. At a minimum, submit the following:
 - a. BMS network architecture diagrams including all nodes and interconnections.
 - b. Systems schematics, sequences and flow diagrams.
 - c. Points schedule for each point in the BMS, including: Point Type, Object Name, Expanded ID, Display Units, Controller type, and Address.
 - d. Samples of Graphic Display screen types and associated menus.
 - e. Detailed Bill of Material list for each system or application, identifying quantities, part numbers, descriptions, and optional features.
 - f. Control Damper Schedule including a separate line for each damper provided under this section and a column for each of the damper attributes, including: Code Number, Fail Position, Damper Type, Damper Operator, Duct Size, Damper Size, Mounting, and Actuator Type.
 - g. Control Valve Schedules including a separate line for each valve provided under this section and a column for each of the valve attributes: Code Number, Configuration, Fail Position, Pipe Size, Valve Size, Body Configuration, Close off Pressure, Capacity, Valve CV, Design Pressure, and Actuator Type.
 - h. Room Schedule including a separate line for each VAV box and/or terminal unit indicating location and address and room thermostat specifics.
 - i. Details of all BMS interfaces and connections to the work of other trades.
 - j. Listing of all read and or write points derived via interfaces to mechanical system components as required per project specifications, sequences of operation, points list(s), and/or required for correct systems operation and functionality. Points shall be identified as to point type (AI, DI, AO, DO, AV, DV), point source (read, write, commandable), interface type (Lon, BACnet, N2, etc.) point ID in BMS and point ID in mechanical system, mechanical system source (VFD, RTU, Chiller, etc.), point (object) name (% speed, fan status, cws temp, etc.) and point description (speed of motor, fan on, chilled water supply temperature, etc.)
 - k. Product data sheet section with an index identifying each product utilized in the installed BMS system and product data sheet(s) for each product. The index shall individually list each product with the associated numerically sequenced page number(s) of the product

data sheets. For all products including software, provide product data sheet(s) or marked catalog pages that include part number, photo, complete specifications and numerically sequenced page number(s) referenced in the index.

6. Submittals shall be developed in conjunction with the requirements of Section 238500. In addition, all submittals, "as-builts" and O & M Manuals shall clearly indicate the location of all controllers and field devices (in Room 123, above corridor ceiling outside Room 456, etc.)

1.6 RECORD DOCUMENTATION

A. Operation and Maintenance Manuals

1. Three (3) copies of the Operation and Maintenance Manuals shall be provided to the Owner's Representative upon completion of the project. The entire Operation and Maintenance Manual shall also be furnished on Compact Disc media, and include the following for the BMS provided:
 - a. Table of contents.
 - b. As-built system record drawings. Computer Aided Drawings (CAD) record drawings shall represent the as-built condition of the system and incorporate all information supplied with the approved submittal.
 - c. Manufacturers product data sheets or catalog pages for all products including software.
 - d. System Operator's manuals.
 - e. Archive copy of all site-specific databases and sequences.
 - f. BMS network diagrams.
 - g. Interfaces to all third-party products and work by other trades.
2. The Operation and Maintenance Manual CD shall be self-contained, and include all necessary software required to access the product data sheets. A logically organized table of contents shall provide dynamic links to view and print all product data sheets. Viewer software shall provide the ability to display, zoom, and search all documents.
3. The Controls Contractor shall provide O & M manuals that are organized in a logical, concise easy to use format. Where changes have occurred from the original submittal package, those changes shall be reflected on the appropriate unit/system/sub-system drawings and not just grouped as a series of partial drawings (i.e. changes only) at the end of the drawing package. In like fashion, new terminal devices shall be logically inserted into the specification data sheet sections according to the type of device(s) involved and not just grouped as a series of new pages at the end of the previous data sheet submittal section. In addition, the BMS overview drawings shall accurately reflect "as-built" conditions, including the integration of communication nodes provided by other manufacturers/trades. To the extent that the original submittal package must be totally redone in order to satisfy these requirements, the Controls Contractor shall make the necessary changes at no additional cost to the owner.
4. O & M Manuals shall be developed in conjunction with the requirements of Section 238500. In addition, all submittals, "as-builts" and O & M Manuals shall clearly indicate the location of all controllers and field devices (in Room 123, above corridor ceiling outside Room 456, etc.)

1.7 WARRANTY

A. Standard Material and Labor Warranty:

1. Provide a three (3)-year labor and material warranty on the BMS.
2. If within three (3) years from the date of final payment, upon written notice from the owner, it is found to be defective in operation, workmanship or materials, it shall be replaced, repaired or adjusted at the option of the BMS Contractor at the cost of the BMS Contractor.

3. Maintain an adequate supply of materials within 100 miles of the Project site such that replacement of key parts and labor support, including programming. Warranty work shall be done during BMS Contractor's normal business hours.

PART 2 - PRODUCTS

2.1 STANDARD OF QUALITY

- A. It is recognized that the BMS design for this project, both hardware and software, represents a specific approach to addressing both owner ease of operation and long term energy efficiency of the completed HVAC project. To that end, this specification clearly establishes MINIMUM hardware, software, installation, commissioning and man-machine interface requirements. While it is clear that there may be distinctions in how different ATC manufacturers configure their hardware and software approaches/solutions for this project, it must be pointed out that this specification establishes MINIMUM STANDARDS APPLICABLE TO ALL named manufacturers. Named manufacturers should not assume that just because they are named as an acceptable manufacturer, they can use lower level hardware and/or software components to meet the functional intent of this specification. Where necessary, because a lower level panel or terminal device fails to satisfy ALL of the specification requirements, manufacturers shall use higher level hardware to satisfy specification requirements, even if all requirements are exceeded in the process. It remains the intent of this specification to require GREATER THAN OR EQUAL TO COMPLIANCE from all manufacturers.

2.2 GENERAL DESCRIPTION

- A. The Building Management System (BMS) shall use an open architecture and fully support a multi-vendor environment. To accomplish this effectively, the BMS shall support open communication protocol standards and integrate a wide variety of third-party devices and applications. The system shall be designed for use on the Internet, or intranets using off the shelf, industry standard technology compatible with other owner provided networks.
- B. The Building Management System shall consist of the following:
 1. Standalone Network Automation Engine(s)
 2. Field Equipment Controller(s)
 3. Input/Output Module(s)
 4. Variable Air Volume Controller(s)
 5. Networked Thermostat Controller(s)
 6. Local Display Device(s)
 7. Distributed User Interface(s)
 8. Network processing, data storage and communications equipment
 9. Graphical Programmer
 10. Graphical User Interface (GUI)
 11. Portable Operator's Terminal (POT)
 12. Workstation Server Hardware Station
 13. Other components required for a complete and working BMS
- C. The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, controllers and operator devices, while re-using existing controls equipment.
- D. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

E. Acceptable Manufacturers

1. The new BMS System shall be an extension of the existing campus wide Trane Tracer Summit system. **NO EXCEPTIONS.**

2.3 BMS ARCHITECTURE

A. Automation Network

1. The automation network shall be based on a PC industry standard of Ethernet TCP/IP. Where used, LAN controller cards shall be standard "off the shelf" products available through normal PC vendor channels.
2. The BMS shall network multiple user interface clients, automation engines, system controllers and application-specific controllers. Provide application and data server(s) as required for systems operation.
3. The automation network shall be capable of operating at a communication speed of 100 Mbps, with full peer-to-peer network communication.
4. Network Automation Engines (NAE) shall reside on the automation network.
5. The automation network will be compatible with other enterprise-wide networks. Where indicated, the automation network shall be connected to the enterprise network and share resources with it by way of standard networking devices and practices.
6. ATC Contractor shall be responsible for providing all labor and materials for implementing automation network level required for this project.

B. Control Network

1. Network Automation Engines shall provide supervisory control over the control network and shall support the following communication protocol:
 - a. BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9.
2. Control networks shall provide either "Peer-to-Peer," Master-Slave, or Supervised Token Passing communications, and shall operate at a minimum communication speed of 9600 baud.
3. DDC Controllers shall reside on the control network.
4. Control network communication protocol shall be BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135.
5. A BACnet Protocol Implementation Conformance Statement shall be provided for each controller device (master or slave) that will communicate on the BACnet MS/TP Bus.
6. ATC Contractor shall be responsible for providing all labor and materials for implementing control network level required for this project.

C. Integration

1. BACnet Protocol Integration - BACnet

- a. The neutral protocol used between systems will be BACnet over Ethernet and comply with the ASHRAE BACnet standard 135-2003.
- b. A complete Protocol Implementation Conformance Statement (PICS) shall be provided for all BACnet system devices.
- c. The ability to command, share point object data, change of state (COS) data and schedules between the host and BACnet systems shall be provided.

2.4 USER INTERFACE

A. Dedicated Web Based User Interface

1. The BMS Contractor shall provide and install a personal computer for command entry, information management, network alarm management, and database management functions. All real-time control functions, including scheduling, history collection and alarming, shall be resident in the BMS Network Automation Engines to facilitate greater fault tolerance and reliability. ADS/ADX Site Director software package shall be installed on PC by the BMS Contractor.
2. Dedicated User Interface Architecture – The architecture of the computer shall be implemented to conform to industry standards, so that it can accommodate applications provided by the BMS Contractor and by other third party applications suppliers, including but not limited to Microsoft Office Applications. Specifically it must be implemented to conform to the following interface standards.
 - a. Microsoft Internet Explorer for user interface functions
 - b. Microsoft Office Professional for creation, modification and maintenance of reports, sequences other necessary building management functions
 - c. Microsoft Outlook or other e-mail program for supplemental alarm functionality and communication of system events, and reports
 - d. Required network operating system for exchange of data and network functions such as printing of reports, trends and specific system summaries.
3. PC Hardware – The personal computer(s) shall be configured as follows:
 - a. Memory – 1 GB (512 MB Minimum)
 - b. CPU– Pentium 4 processor. 2.8 GHz Clock Speed (2.0 GHz minimum)
 - c. Hard Drive – 80 GB free hard drive space (40GB minimum)
 - d. Hard drive backup system – CD/RW, DVD/RW or network backup software provided by IT department
 - e. CD ROM Drive – 32X performance
 - f. Ports – (2) Serial and (1) parallel, (2) USB ports
 - g. Keyboard – 101 Keyboard and 2 Button Mouse
 - h. CRT configuration – 2 CRTs as follows:
 - Each Display – 17” Flat Panel Monitor 1280 x 1024 resolution minimum.
 - 16 bit or higher color resolution
 - Display card with multiple monitor support
 - i. LAN communications – Ethernet communications board; 3Comm or equal.
4. Operating System Software
 - a. Windows 2000 Professional or newer.
 - b. Where user interface is not provided via browser, provide complete operator workstation software package, including any hardware or software keys. Include the original installation disks and licenses for all included software, device drivers, and peripherals.
 - c. Provide software registration cards to the Owner for all included software.

5. Peripheral Hardware

- a. Reports printer:
Printer Make – Hewlett Packard DeskJet
Print Speed – 600 DPI Black, 300 DPI Color
Buffer – 64 K Input Print Buffer
Color Printing – Include Color Kit

B. Distributed Web Based User Interface

1. All features and functions of the dedicated user interface defined in this document shall be available on any computer connected directly or via a wide area or virtual private network (WAN/VPN) to the automation network and conforming to the following specifications.
2. The software shall run on the Microsoft Internet Explorer (6.0 or higher) browser.
3. Minimum hardware requirements:
256 MB RAM
2.0 GHz Clock Speed Pentium 4 Microprocessor.
40.0 GB Hard Drive.
1 Keyboard with 83 keys (minimum).
SVGA 1024x768 resolution display with 64K colors and 16 bit color depth.
Mouse or other pointing device

C. User Interface Application Components

1. Operator Interface
 - a. An integrated browser based client application shall be used as the user operator interface program.
 - b. All Inputs, Outputs, Setpoints, and all other parameters as defined by the contract documents, or required as part of the system software, shall be displayed for operator viewing and modification from the operator interface software.
 - c. The user interface software shall provide help menus and instructions for each operation and/or application.
 - d. All controller software operating parameters shall be displayed for the operator to view/modify from the user interface. These include: setpoints, alarm limits, time delays, PID tuning constants, run-times, point statistics, schedules, and so forth.
 - e. The Operator Interface shall incorporate comprehensive support for functions including, but not necessarily limited to, the following:
 - User access for selective information retrieval and control command execution
 - Monitoring and reporting
 - Alarm, non-normal, and return to normal condition annunciation
 - Selective operator override and other control actions
 - Information archiving, manipulation, formatting, display and reporting
 - BMS internal performance supervision and diagnostics
 - On-line access to user HELP menus
 - On-line access to current BMS as-built records and documentation. Sequence of operation information, shop drawings and specification data sheets associated with a system shall be available from the colorgraphic screen associated with that system. This feature shall be fully implemented for the colorgraphic screens created for this project.

Means for the controlled re-programming, re-configuration of BMS operation and for the manipulation of BMS database information in compliance with the prevailing codes, approvals and regulations for individual BMS applications.

- f. The operation of the control system shall be independent of the user interface, which shall be used for operator communications only. Systems that rely on an operator workstation to provide supervisory control over controller execution of the sequences of operations or system communications shall not be acceptable.

2. Navigation Trees

- a. The system will have the capability to display multiple navigation trees that will aid the operator in navigating throughout all systems and points connected. At minimum provide a tree that identifies all systems on the networks.
- b. Provide the ability for the operator to add custom trees. The operator will be able to define any logical grouping of systems or points and arrange them on the tree in any order. It shall be possible to nest groups within other groups. Provide at minimum 5 levels of nesting.
- c. The navigation trees shall be "dockable" to other displays in the user interface such as graphics. This means that the trees will appear as part of the display, but can be detached and then minimized to the Windows task bar or closed altogether. A simple keystroke will reattach the navigation to the primary display of the user interface.

3. Alarms

- a. Alarms shall be routed directly from Network Automation Engines to PCs and servers. It shall be possible for specific alarms from specific points to be routed to specific PCs and servers. The alarm management portion of the user interface shall, at the minimum, provide the following functions:

Log date and time of alarm occurrence.

Generate a "Pop-Up" window, with audible alarm, informing a user that an alarm has been received.

Allow a user, with the appropriate security level, to acknowledge, temporarily silence, or discard an alarm.

Provide an audit trail on hard drive for alarms by recording user acknowledgment, deletion, or disabling of an alarm. The audit trail shall include the name of the user, the alarm, the action taken on the alarm, and a time/date stamp.

Provide the ability to direct alarms to an e-mail address or alphanumeric pager. This must be provided in addition to the pop up window described above. Systems that use e-mail and pagers as the exclusive means of annunciating alarms are not acceptable. BMS Contractor shall coordinate implementation of this feature with the owner as part of the work of this project.

Any attribute of any object in the system may be designated to report an alarm.

- b. The BMS shall annunciate diagnostic alarms indicating system failures and non-normal operating conditions
- c. The BMS shall annunciate application alarms at minimum, as required by the contract documents.

4. Reports and Summaries

- a. Reports and Summaries shall be generated and directed to the user interface displays, with subsequent assignment to printers, or disk. As a minimum, the system shall provide the following fully implemented reports:

- All points in the BMS
- All points in each BMS application
- All points in a specific controller
- All points in a user-defined group of points
- All points currently in alarm
- All points locked out
- All BMS schedules

All user defined and adjustable variables, schedules, interlocks and the like.

- b. Summaries and Reports shall be accessible via standard UI functions and not dependent upon custom programming or user defined HTML pages.
- c. Selection of a single menu item, tool bar item, or tool bar button shall print any displayed report or summary on the system printer for use as a building management and diagnostics tool.
- d. The system shall allow for the creation of custom reports and queries via a standard web services XML interface and commercial off-the-shelf software such as Microsoft Access, Microsoft Excel, or Crystal Reports.

5. Schedules

- a. A graphical display for time-of-day scheduling and override scheduling of building operations shall be provided. At a minimum, the following functions shall be provided and fully implemented in accordance with the requirements of the contract documents:
 - Weekly schedules
 - Exception Schedules
 - Monthly calendars.
- b. Weekly schedules shall be provided for each group of equipment with a specific time use schedule.
- c. It shall be possible to define one or more exception schedules for each schedule including references to calendars
- d. Monthly calendars shall be provided that allow for simplified scheduling of holidays and special days for a minimum of five years in advance. Holidays and special days shall be user-selected with the pointing device or keyboard, and shall automatically reschedule equipment operation as previously defined on the exception schedules.
- e. Changes to schedules made from the User Interface shall directly modify the Network Automation Engine schedule database.
- f. Schedules and Calendars shall comply with ASHRAE SP135/2003 BACnet Standard.
- g. Selection of a single menu item or tool bar button shall print any displayed schedule on the system printer for use as a building management and diagnostics tool.

6. Password

- a. Multiple-level password access protection shall be provided to allow the user/manager to user interface control, display, and database manipulation capabilities deemed appropriate for each user, based on an assigned password.
- b. Each user shall have the following: a user name (24 characters minimum), a password (12 characters minimum), and access levels.
- c. The system shall allow each user to change his or her password at will.
- d. When entering or editing passwords, the system shall not echo the actual characters for display on the monitor.
- e. A minimum of five levels of access shall be supported individually or in any combination as follows:
 - Level 1 = View Data
 - Level 2 = Command

- Level 3 = Operator Overrides
- Level 4 = Database Modification
- Level 5 = Database Configuration
- Level 6 = All privileges, including Password Add/Modify

- f. A minimum of 100 unique passwords shall be supported.
 - g. Operators shall be able to perform only those commands available for their respective passwords. Display of menu selections shall be limited to only those items defined for the access level of the password used to log-on.
 - h. The system shall automatically generate a report of log-on/log-off and system activity for each user. Any action that results in a change in the operation or configuration of the control system shall be recorded, including: modification of point values, schedules or history collection parameters, and all changes to the alarm management system, including the acknowledgment and deletion of alarms.
7. Screen Manager - The User Interface shall be provided with screen management capabilities that allow the user to activate, close, and simultaneously manipulate a minimum of 4 active display windows plus a network or user defined navigation tree.
8. Dynamic Color Graphics
- a. The graphics application program shall be supplied as an integral part of the User Interface. Browser or Workstation applications that rely only upon HTML pages shall not be acceptable.
 - b. The graphics applications shall include a create/edit function and a runtime function. The system architecture shall support an unlimited number of graphics documents (graphic definition files) to be generated and executed. The graphics shall display and provide animation based on real-time data that is acquired, derived, or entered.
 - c. Graphics runtime functions – A maximum of 16 graphic applications shall be able to execute at any one time on a user interface or workstation with 4 visible to the user. Each graphic application shall be capable of the following functions:
 - All graphics shall be fully scalable
 - The graphics shall support a maintained aspect ratio.
 - Multiple fonts shall be supported.
 - Unique background shall be assignable on a per graphic basis.
 - The color of all animations and values on displays shall indicate if the status of the object attribute.
 - d. Operation from graphics – It shall be possible to change values (setpoints) and states in system controlled equipment by using drop-down windows accessible via the pointing device
 - e. Graphic editing tool – A graphic editing tool shall be provided that allows for the creation and editing of graphic files. The graphic editor shall be capable of performing/defining all animations, and defining all runtime binding.
 - The graphic editing tool shall in general provide for the creation and positioning of point objects by dragging from tool bars or drop-downs and positioning where required.
 - In addition, the graphic editing tool shall be able to add additional content to any graphic by importing backgrounds in the SVG, BMP or JPG file formats.
 - f. Aliasing – Many graphic displays representing part of a building and various building components are exact duplicates, with the exception that the various variables are bound to different field values. Consequently, it shall be possible to bind the value of a graphic display to aliases, as opposed to the physical field tags.
9. Historical trending and data collection
- a. Each Automation Engine shall store trend and point history data for all analog and digital inputs and outputs, as follows:

Any point, physical or calculated, may be designated for trending. Two methods of collection shall be allowed:

Defined time interval

Upon a change of value

Each Automation Engine shall have the capability to store multiple samples for each physical point and software variable based upon available memory, including an individual sample time/date stamp. Points may be assigned to multiple history trends with different collection parameters.

- b. Trend and change of value data shall be stored within the engine and uploaded to a dedicated trend database or exported in a selectable data format via a provided data export utility. Uploads to a dedicated database shall occur based upon one of the following: user-defined interval, manual command, or when the trend buffers are full. Exports shall be as requested by the user or on a time scheduled basis. Fully implemented trends, including automatic uploads to a dedicated database shall be provided in accordance with the requirements of the contract documents.
- c. The system shall provide a configurable data storage subsystem for the collection of historical data. Data can be stored in either Microsoft Access or SQL database format.

10. Trend data viewing and analysis

- a. Provide a trend viewing utility that shall have access to all database points.
- b. It shall be possible to retrieve any historical database point for use in displays and reports by specifying the point name and associated trend name.
- c. The trend viewing utility shall have the capability to define trend study displays to include multiple trends
- d. Displays shall be able to be single or stacked graphs with on-line selectable display characteristics, such as ranging, color, and plot style.
- e. Display magnitude and units shall both be selectable by the operator at any time without reconfiguring the processing or collection of data. This is a zoom capability.
- f. Display magnitude shall automatically be scaled to show full graphic resolution of the data being displayed.
- g. Trend studies shall be capable of calculating and displaying calculated variables including highest value, lowest value and time based accumulation.

2.5 NETWORK AUTOMATION ENGINES (NAE)

A. Network Automation Engine

- 1. The Network Automation Engine (NAE) shall be a fully user-programmable, supervisory controller. The NAE shall monitor the network of distributed application-specific BACnet controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Network Automation Engines. NAE shall support the BACnet services and objects typically used by a workstation and a field controller device, including BACnet alarm and event services. NAE shall communicate via the MS/TP bus with the Metasys FEC family of BACnet application specific controllers (B-ASC).
- 2. Automation network – The NAE shall reside on the automation network and shall support a subnet of system controllers.
- 3. User Interface – Each NAE shall have the ability to deliver a web based User Interface (UI) as previously described. All computers connected physically or virtually to the automation network shall have access to the web based UI.
 - a. The web based UI software shall be imbedded in the NAE. Systems that require a local copy of the system database on the user's personal computer are not acceptable.
 - b. The NAE shall support up a minimum of four (4) concurrent users.

- c. The web based user shall have the capability to access all system data through one NAE.
- d. Remote users connected to the network through an Internet Service Provider (ISP) or telephone dial up shall also have total system access through one NAE.
- e. Systems that require the user to address more than one NAE to access all system information are not acceptable.
- f. The NAE shall have the capability of generating web based UI graphics. The graphics capability shall be imbedded in the NAE.
- g. Systems that support UI Graphics from a central database or require the graphics to reside on the user's personal computer are not acceptable.
- h. The web based UI shall support the following functions using a standard version of Microsoft Internet Explorer:

- Configuration
- Commissioning
- Data Archiving
- Monitoring
- Commanding
- System Diagnostics

- i. Systems that require workstation software or modified web browsers are not acceptable.
 - j. The NAE shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems.
- 4. Processor – The NAE shall be microprocessor-based with a minimum word size of 32 bits. The NAE shall be a multi-tasking, multi-user, and real-time digital control processor. Standard operating systems shall be employed. NAE size and capability shall be sufficient to fully meet the requirements of the contract documents.
 - 5. Memory – Each NAE shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all control level devices.
 - 6. Hardware Real Time Clock – The NAE shall include an integrated, hardware-based, real-time clock.
 - 7. The NAE shall include troubleshooting LED indicators to identify the following conditions:
 - a. Power - On/Off
 - b. Ethernet Traffic – Ethernet Traffic/No Ethernet Traffic
 - c. Ethernet Connection Speed – 10 Mbps/100 Mbps
 - d. FC Bus A – Normal Communications/No Field Communications
 - e. FC Bus B – Normal Communications/No Field Communications
 - f. Peer Communication – Data Traffic Between NAE Devices
 - g. Run – NAE Running/NAE In Startup/NAE Shutting Down/Software Not Running
 - h. Bat Fault – Battery Defective, Data Protection Battery Not Installed
 - i. 24 VAC – 24 VAC Present/Loss Of 24VAC
 - j. Fault – General Fault
 - k. Modem RX – NAE Modem Receiving Data
 - l. Modem TX – NAE Modem Transmitting Data
 - 8. Communications Ports – The NAE shall provide the following ports for operation of operator Input/Output (I/O) devices, such as industry-standard computers, modems, and portable operator's terminals.
 - a. Two (2) USB port
 - b. Two (2) URS-232 serial data communication port
 - c. Two (2) RS-485 port (BACnet MS/TP trunks)
 - d. One (1) Ethernet port

9. **Diagnostics** – The NAE shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The Network Automation Engine shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failures to establish communication.
10. **Power Failure** – In the event of the loss of normal power, The NAE shall continue to operate for a user adjustable period of up to 10 minutes after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software.
 - a. During a loss of normal power, the control sequences shall go to the normal system shutdown conditions. All critical configuration data shall be saved into Flash memory.
 - b. Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.
11. **Certification** – The NAE shall be listed by Underwriters Laboratories (UL).
12. **Controller network** – The NAE shall support the following communication protocols on the controller network:
 - a. The NAE shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.

A BACnet Protocol Implementation Conformance Statement shall be provided for each controller device (master or slave) that will communicate on the BACnet MS/TP Bus.

The NAE shall support a minimum of 100 control devices.

2.6 DDC SYSTEM CONTROLLERS

A. Field Equipment Controller

1. The Field Equipment Controller (FEC) with display (HWS, CWS, AHU/RTUs only) shall be a fully user-programmable, digital controller that communicates via BACnet MS/TP protocol.
2. The FEC shall employ a finite state control engine to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences. Suppliers using non-state based DDC shall provide separate control strategy diagrams for all controlled functions in their submittals.
3. Controllers shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only shall not be acceptable.
4. The FEC shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.
5. The FEC shall include a removable base to allow pre-wiring without the controller.
6. The FEC shall include troubleshooting LED indicators to identify the following conditions:
 - a. Power On
 - b. Power Off
 - c. Download or Startup in progress, not ready for normal operation
 - d. No Faults
 - e. Device Fault
 - f. Field Controller Bus - Normal Data Transmission
 - g. Field Controller Bus - No Data Transmission
 - h. Field Controller Bus - No Communication
 - i. Sensor-Actuator Bus - Normal Data Transmission
 - j. Sensor-Actuator Bus - No Data Transmission

- k. Sensor-Actuator Bus - No Communication
- 7. The FEC shall accommodate the direct wiring of analog and binary I/O field points.
- 8. The FEC shall support the following types of inputs and outputs:
 - a. Universal Inputs - shall be configured to monitor any of the following:
 - Analog Input, Voltage Mode, 0-10 VDC
 - Analog Input, Current Mode, 4-20 mA
 - Analog Input, Resistive Mode
 - Binary Input, Dry Contact Maintained Mode
 - b. Binary Inputs - shall be configured to monitor either of the following:
 - Dry Contact Maintained Mode
 - Pulse Counter Mode
 - c. Analog Outputs - shall be configured to output either of the following:
 - Analog Output, Voltage Mode, 0-10 VDC
 - Analog Output, current Mode, 4-20 mA
 - d. Binary Outputs - shall output the following:
 - 24 VAC Triac
 - e. Configurable Outputs - shall be capable of the following:
 - Analog Output, Voltage Mode, 0-10 VDC
 - Binary Output Mode, 24 VAC Triac
- 9. The FEC shall have the ability to reside on a Field Controller Bus (FC Bus).
 - a. The FC Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard protocol SSPC-135, Clause 9.
 - b. The FC Bus shall support communications between the FECs and the NAE.
 - c. The FC Bus shall also support Input/Output Module (IOM) communications with the FEC and with the NAE.
 - d. The FC Bus shall support a minimum of 100 IOMs and FECs in any combination.
 - e. The FC Bus shall operate at a maximum distance of 15,000 Ft. between the FEC and the furthest connected device.
- 10. The FEC shall have the ability to monitor and control a network of sensors and actuators over a Sensor-Actuator Bus (SA Bus).
 - a. The SA Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard protocol SSPC-135, Clause 9.
 - b. The SA Bus shall support a minimum of 10 devices per trunk.
 - c. The SA Bus shall operate at a maximum distance of 1,200 Ft. between the FEC and the furthest connected device.
- 11. The FEC shall have the capability to execute complex control sequences involving direct wired I/O points as well as input and output devices communicating over the FC Bus or the SA Bus.

12. FEC shall be available in a 10 point version (2 UI, 1 BI, 3 BO, 4 CO) and a 17 point version (6 UI, 2 BI, 3 BO, 2 AO, 4 CO). FEC shall be able to expand I/O point capacity via the addition of Input/Output Modules and Network Sensors.
13. The FEC shall support, but not be limited to, the following:
 - a. Hot water, chilled water/central plant applications
 - b. Rooftop units for special applications
 - c. Terminal units
 - . Special programs as required for systems control

B. Input/Output Module

1. The Input/Output Module (IOM) provides additional inputs and outputs for use in the associated FEC.
2. The IOM shall communicate with the FEC over the SA Bus using BACnet Standard protocol SSFC-135, Clause 9.
3. The IOM shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.
- 4.. The IOM shall be available in 4 point (4 BI), 6 point (2 UI, 2UO, 2 RO), 12 point (4 UI, 4 UO, 4 RO) and 17 point (6 UI, 2 BI, 2 AO, 3 BO, 4 CO) versions.
5. The IOM shall support the following types of inputs and outputs:
 - a. Universal Inputs - shall be configured to monitor any of the following:
 - Analog Input, Voltage Mode, 0-10 VDC
 - Analog Input, Current Mode, 4-20 mA
 - Analog Input, Resistive Mode
 - Binary Input, Dry Contact Maintained Mode
 - b. Binary Inputs - shall be configured to monitor either of the following:
 - Dry Contact Maintained Mode
 - Pulse Counter Mode
 - c. Analog Outputs - shall be configured to output either of the following
 - Analog Output, Voltage Mode, 0-10 VDC
 - Analog Output, current Mode, 4-20 mA
 - d. Binary Outputs - shall output the following:
 - 24 VAC Triac
 - e. Universal Output - shall be configured to output any of the following
 - Analog Output, Voltage Mode, 0-10 VDC
 - Analog Output, current Mode, 4-20 mA
 - Binary Outpu Mode, 24 V AC/DC FET
 - f. Relay Output - 120/240 VAC
 - g. Configurable Outputs - shall be capable of the following:
 - Analog Output, Voltage Mode, 0-10 VDC
 - Binary Output Mode, 24 VAC Triac

6. The IOM shall include troubleshooting LED indicators to identify the following conditions:

- a. Power On
- b. Power Off
- c. Download or Startup in progress, not ready for normal operation
- d. No Faults
- e. Device Fault
- f. Normal Data Transmission
- g. No Data Transmission
- h. No Communication

C. Variable Air Volume Controller

1. The Variable Air Volume Modular Assembly (VMA) controller shall be a -programmable, digital controller that communicates via BACnet MS/TP protocol.
2. VMA shall include an integrated pressure sensor (0 to 1.5 in WC) and actuator (35 lb-in) in a pre-wired unit.
3. VMA shall connect to NS Series Network Sensors for zone and discharge air temperature sensing.
4. Actuator shall have 60 second drive time from full open to full closed position..
5. VMA point capacity shall be capable of being expanded by adding IOMs to the Sensor Actuator bus.
6. VMA shall support up to 4 zone temperature sensors and 5 discharge air temperature sensors.(on the SA bus)
7. VMA shall be available in two versions:
 - a. Cooling only version
 - b. Cooling with reheat version (3 BO and 2 CO added)

D. Networked Thermostat Controller

1. Networked Thermostat Controller shall be a networked device that communicates via BACnet MS/TP protocol.
2. Networked Thermostat Controller shall be available with occupancy sensing capability built into the device.
3. Networked Thermostat Controller BACnet MS/TP communication capability shall enable remote monitoring and programming from the operator workstation.
4. Networked Thermostat Controller shall employ a unique, Proportional-Integral (PI) time-proportioning algorithm that virtually eliminates temperature offset associated with traditional, differential-based thermostats...
5. Networked Thermostat Controller shall be available in multiple versions to better match application requirements. Additional features include, but are not limited to, the following:
 - a. Occupancy override
 - b. Fan on/off and speed control
 - c. Discharge air sensor
 - d. Configurable binary inputs

E. Network Sensors (NS-XXX700X)

1. The Network Sensors (NS) shall have the ability to monitor the following variables as required by the systems sequence of operations:
 - a. Zone Temperature (range of +/- 3 degrees F from setpoint)
 - b. Zone humidity
 - c. Zone setpoint

2. The NS shall transmit the zone information back to the controller on the Sensor-Actuator Bus (SA Bus) using BACnet Standard protocol SSPC-135, Clause 9.
3. The Network Sensors shall include the following items:
 - a. A backlit Liquid Crystal Display (LCD) to indicate the Temperature, Humidity and Setpoint.
 - b. An LED to indicate the status of the Override feature. (2 hour time frame, adj.)
 - c. A button to toggle the temperature display between Fahrenheit and Celsius.
 - d. A button to initiate a timed override command
4. The NS shall be available with either screw terminals or phone jack.
5. The NS shall be available in either surface mount or wall mount styles.

2.7 OPERATOR TOOLS

A. A Graphical Programmer's utility tool shall be provided. The GP is a graphical object-oriented drawing tool that provides an intuitive interface for programming, compiling and downloading control applications to BACnet controllers. An application shall represent all of the control logic in a controller. All BACnet controllers shall be programmed using the GP. The utility shall be capable of downloading application programs to all of the devices within the BMS.

B. Portable Operator's Terminal

1. Provide a Portable Operator's Terminal (POT) color display personal computer, software, and interfaces to provide; uploading/downloading of Controller databases, monitoring and overrides of all controller physical input/output points, and editing of controller resident time schedules. POT connectivity shall be via digital wall sensor connected to controller.
2. Connection of a POT to the Controller shall not interfere with normal network operation in any way, prevent alarms from being transmitted or centrally initiated commands from being executed.
3. Functionality of the POT connected to any controller shall include:

Uploads and downloads Controller databases.

Editing of minor equipment operational parameters (including minimum on/off and delay times, changeover values, minimum position setpoints, etc.). All such mechanical equipment editable values shall contain internal Controller safety range limits to prevent accidental entry of out of range or invalid values.

Monitoring and overrides of all controller physical input/output points including timed overrides that automatically revert back to their normal value.

Display of digital sensor values including diagnostics and calibration.

Editing of controller time/date.

Editing and overrides of resident Controller time schedules.

2.8 INPUT DEVICES

A. General Requirements

1. Installation, testing, and calibration of all sensors, transmitters, and other input devices shall be provided to meet the system requirements.
2. Hardware safeties (freezestat., firestat, high/low static, smoke detector, etc.) shall be auto reset type. DDC controller software shall include provisions to automatically restart equipment after alarm condition clears. In addition, controller software shall lock-out auto restart capability after a safety trips 3 (adj.) times in a 12 hour period. Auto restart capability lock-out shall be alarmed at the central operator workstation as well as text messaged to designated owner personnel.

3. Hardware safeties (freezestat., firestat, high/low static, smoke detector, etc.) shall be hardwired to their associated starter, VFD, etc. The hardware terminal device shall include an auxiliary set of contacts for input of alarm condition to the DDC system. Hardware safety alarm trips shall be alarmed at the central operator workstation as well as text messaged to designated owner personnel.

B. Temperature Sensors

1. General Requirements:

- a. Sensors and transmitters shall be provided, as outlined in the input/output summary and sequence of operations.
- b. The temperature sensor shall be of the resistance type, and shall be either two-wire 1000 ohm nickel RTD, or two-wire 1000 ohm platinum RTD.
- c. The following point types (and the accuracy of each) are required, and their associated accuracy values include errors associated with the sensor, lead wire, and A to D conversion:

Point Type	Accuracy
Room Temp	+ .5 F.
Duct Temperature	+ .5 F.
All Others	+ .75 F.

2. Room Temperature Sensors

- a. Room sensors shall be constructed for either surface or wall box mounting.
- b. Room sensors shall have the following options when specified:

Setpoint reset slide switch providing a +3 degree (adjustable) range.
Individual heating/cooling setpoint slide switches.
A momentary override request push button for activation of after-hours operation.
Analog thermometer.

3. Room Temperature Sensors with Integral Display

- a. Room sensors shall be constructed for either surface or wall box mounting.
- b. Room sensors shall have an integral LCD display and four button keypad with the following capabilities:
 - Display room and outside air temperatures.
 - Display and adjust room comfort setpoint.
 - Display and adjust fan operation status.
 - Timed override request push button with LED status for activation of after-hours operation.
 - Display controller mode.
 - Password selectable adjustment of setpoint and override modes.

4. Outside Air Sensors

- a. Outside air sensors shall be designed to withstand the environmental conditions to which they will be exposed. They shall also be provided with a solar shield.
- b. Sensors exposed to wind velocity pressures shall be shielded by a perforated plate that surrounds the sensor element.
- c. Temperature transmitters shall be of NEMA 3R construction and rated for ambient temperatures.

5. Duct Mount Sensors

- a. Duct mount sensors shall mount in an electrical box through a hole in the duct, and be positioned so as to be easily accessible for repair or replacement.
- b. Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.
- c. For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.

6. Averaging Sensors

- a. For ductwork greater in any dimension than 48 inches and/or where air temperature stratification exists, an averaging sensor with multiple sensing points shall be used.
- b. For plenum applications, such as mixed air temperature measurements, a string of sensors mounted across the plenum shall be used to account for stratification and/or air turbulence. The averaging string shall have a minimum of 4 sensing points per 12-foot long segment.
- c. Capillary supports at the sides of the duct shall be provided to support the sensing string.
- d. Acceptable Manufacturers: Honeywell, Johnson Controls, Siemens or Setra.

7. Humidity Sensors

- a. The sensor shall be a solid-state type, relative humidity sensor of the Bulk Polymer Design. The sensor element shall resist service contamination.
- b. The humidity transmitter shall be equipped with non-interactive span and zero adjustments, a 2-wire isolated loop powered, 4-20 mA, 0-100% linear proportional output.
- c. The humidity transmitter shall meet the following overall accuracy, including lead loss and Analog to Digital conversion. 3% between 20% and 80% RH @ 77 Deg F unless specified elsewhere.
- d. Outside air relative humidity sensors shall be installed with a rain proof, perforated cover. The transmitter shall be installed in a NEMA 3R enclosure with sealtite fittings and stainless steel bushings.
- e. A single point humidity calibrator shall be provided, if required, for field calibration. Transmitters shall be shipped factory pre-calibrated.
- f. Duct type sensing probes shall be constructed of 304 stainless steel, and shall be equipped with a neoprene grommet, bushings, and a mounting bracket.
- g. Acceptable Manufacturers: Johnson Controls, Veris Industries, and Mamac.
- h. Sensor shall include both wall mounted sensors and duct mounted sensors. See plans for humidity sensor locations.

8. Carbon Dioxide (CO2) Space Sensor

- a. Sensor shall be wall mounted type.
- b. Sensor to be used for sensing carbon dioxide (CO2) level in accordance with the single-beam, dual-wavelength method.
- c. No Maintenance or recalibration required.
- d. CO2 measuring range: 0 to 2000 ppm; accuracy: +/- 30 ppm CO2 + 2% of reading.
- e. Selectable Output of: 0 to 20 mA or 4 to 20 mA or 0 to 10 VDC.
- f. 24 VAC power.
- g. Johnson Controls CD-Wxx Series Wall Mount CO2 with Display or Telaire 8000 series. (Honeywell or Siemens equivalent)

C. Smoke Detectors

1. Ionization type air duct detectors shall be furnished as specified elsewhere in Division 26 for installation under Division 23. Detector shall be wired to de-energize the unit upon sensing a smoke condition with the airstream of the unit. Interlock wiring shall be by the ATC contractor from auxiliary contacts provided by the electrical contractor. Power wiring and wiring from the smoke detector to the fire alarm panel shall be provided by the Electrical Contractor

D. Status and Safety Switches

1. General Requirements

- a. Switches shall be provided to monitor equipment status, safety conditions, and generate alarms at the BMS when a failure or abnormal condition occurs. Safety switches shall be provided with two sets of contacts and shall be interlock wired to shut down respective equipment.

2. Current Sensing Switches

- a. The current sensing switch shall be self-powered with solid-state circuitry and a dry contact output. It shall consist of a current transformer, a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay, and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over-current up to twice its trip point range.
- b. Current sensing switches shall be used for run status for fans, pumps, and other miscellaneous motor loads.
- c. Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.
- d. Acceptable manufacturers: Veris Industries

3. Low Temperature Limit Switches

- a. The low temperature limit switch shall be of the manual reset type with Double Pole/Single Throw snap acting contacts rated for 16 amps at 120VAC.
- b. The sensing element shall be a minimum of 15 feet in length and shall react to the coldest 18-inch section. Element shall be mounted horizontally across duct in accordance with manufacturers recommended installation procedures.
- c. For large duct areas where the sensing element does not provide full coverage of the air stream, additional switches shall be provided as required to provide full protection of the air stream.
- d. The low temperature limit switch shall be equal to Johnson Controls A70.

E. Differential Pressure Switches

1. Air type: Shall be diaphragm actuated type with a single-pole, double-throw, snap-acting switch. Motion of the diaphragm shall be restrained by a calibrated spring that can be adjusted to set the exact pressure differential at which the electrical switch will be actuated. Motion of the diaphragm shall be transmitted to the switch button by means of a direct mechanical linkage. Electrical rating shall be 6.0 amps at 120 VAC. Pressure range and temperature limits shall be suitable for the application. Switch shall be utilized in conjunction with static pressure probes when utilized across filters, and a static pressure probe on the low side and a velocity probe on the high side when utilized across a fan.
2. Water type: Shall be diaphragm-actuated type with a single-pole, double-throw snap-acting switch. Motion of the diaphragm shall be restrained by a calibrated spring that can be adjusted to

set the exact pressure differential at which the electrical switch will be actuated. Switch shall be utilized in conjunction with shut off valves on the low and high sides of the switch to allow for ease of service.

F. Duct Shielded Static Pressure Probe Probes shall be complete with mounting bracket, noise suppression chamber and brass compression connector.

G. Differential Pressure Transmitters

1. Air type: Transmitter shall be provided in a NEMA enclosure with barbed fittings for connection of signal lines. Wiring terminations shall be short circuit and reverse polarity protected. Accuracy shall be +/- 1 % full scale with an over pressure rating of 10 psid. Transmitter shall be temperature compensated from 25 to 150 deg. F. with an operating range of 0 to 175 deg. F. Output shall be 4 to 20 ma.
2. Wet type: Shall be enclosed in a NEMA enclosure with a 5 valve bypass assembly. Transmitter shall have an over pressure rating of at least 200 psi on either port without permanent damage. Transmitter shall have externally accessible zero and span adjustments. Transmitter shall have a static error band of +/- .5% full scale including linearity, hysteresis and repeatability. Output of transmitter shall be 4 to 20 ma.
3. Industrial Grade: Shall use silicon strain gauge technology and a two-wire d/p Cell transmitter to measure the difference between two pressures and transmit a proportional (or square root) 4-20 mA output signal. Differential pressure transmitters shall be used in conjunction with Venturi Flow Stations and shall be as manufactured by Foxboro, Rosemount or approved equal with the following specification requirements:

Zero Suppression: To upper range limit minus the span

Ambient Temperature Effect: Total effect for a 100 DEGF change within Normal Operating Conditions limits is + or - (0.2% of URL +0.1% of span)

Accuracy (Includes linearity, Hysteresis, and Repeatability): + or - 0.20% of calib. span for spans less than 6.7% of URL

Overrange Limit (DP) and Maximum Static Pressure: 25 Mpa, 3625 psi, 250 bar or kg/(cm*cm). Either side may be higher pressure during overrange.

H. Space Static Pressure Sensing Probes: Shall be constructed of brushed aluminum with clear anodized finish and suitable for wall or ceiling mounting. Probes shall sense static pressure within 1% of actual even while subjected to radial air flow source of up to 1000 FPM.

I. Industrial Grade Instrumentation (Central Plants)

1. Level Switch: Shall be configured for four (4) actuation levels and shall have a SPST electrical switch (20 VA minimum with #18 AWG lead wires) associated with each level. Switches shall be UL recognized. Level switch shall have stainless steel mountings and stainless steel floats and accessories. Level switch overall length and mounting type shall be determined by the application. Level switch shall be LS-800 Series as manufactured by GEMS Sensors or approved equal.

2.9 OUTPUT DEVICES

A. ACTUATORS

1. General Requirements

- a. Damper and valve actuators shall be electronic and/or pneumatic, as specified in the System Description section.
2. Electronic Damper Actuators
 - a. Electronic damper actuators shall be direct shaft mount.
 - b. Modulating and two-position actuators shall be provided as required by the sequence of operations. Damper sections shall be sized Based on actuator manufacturer's recommendations for face velocity, differential pressure and damper type. The actuator mounting arrangement and spring return feature shall permit normally open or normally closed positions of the dampers, as required. All actuators (except terminal units) shall be furnished with mechanical spring return unless otherwise specified in the sequences of operations. All actuators shall have external adjustable stops to limit the travel in either direction, and a gear release to allow manual positioning.
 - c. Modulating actuators shall accept 24 VAC or VDC power supply, consume no more than 15 VA, and be UL listed. The control signal shall be 2-10 VDC or 4-20 mA, and the actuator shall provide a clamp position feedback signal of 2-10 VDC. The feedback signal shall be independent of the input signal and may be used to parallel other actuators and provide true position indication. The feedback signal of one damper actuator for each separately controlled damper shall be wired back to a terminal strip in the control panel for trouble-shooting purposes.
 - d. Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Isolation, smoke, exhaust fan, and other dampers, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop associated fan. Two-position actuators, as specified in sequences of operations as "quick acting," shall move full stroke within 20 seconds. All smoke damper actuators shall be quick acting.
 - e. All actuators used on outdoor air intake or relief dampers or actuators used on terminal equipment (air handling units and other equipment with outdoor air intakes, etc.) control valves shall be of the spring return to fail-safe position type. Non-spring return actuators shall not be acceptable. Batteries used to provide fail safe operation shall not be acceptable.
 - f. Acceptable manufacturers: Honeywell, Johnson Controls or Siemens.
- B. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated All valves shall be fully modulating unless otherwise indicated. ATC Contractor shall be responsible for selection of proper control valves for project, in accordance with the parameters defined by the following paragraphs, including sizing, pressure rating, flow coefficient, flow characteristic, close-off rating and allowable leakage factor. Valve construction shall be as follows with NO EXCEPTIONS. Globe valves shall be used for all AHU/RTU and UV applications, ball valves shall be used for all VAV hot water coils and FCU hot/chilled water coils, and terminal unit control valves shall be used for CUH/HUH.
 1. Globe Valves NPS 2" and Smaller: Bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure. Valves shall have allowable media temperature of 20°F to 281°F to assure that the valve packing will have a long life (valves will narrower allowable media temperatures have no reserve packing capability for long term watertight seal).
 2. Globe Valves NPS 2-1/2" and Larger: Iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.
 3. Hydronic system globe valves shall have the following characteristics:

4. Rating: Class 125 for service at 125 psig. and 250°F operating conditions.
5. Internal Construction: Replaceable plugs and seats of stainless steel or brass.
 - a. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom of guided plugs.
 - b. Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom of guided plugs.
 - c. Sizing: 3 psig. maximum pressure drop at design flow rate.
 - d. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics. Operators shall close valves against pump shutoff head.
 - e. Control Ball Valves 3 inches and smaller (2 inches for 3-way valves): Forged brass body (CuZn39Pb2), chrome plated brass ball and blowout proof stem and EPDM o-rings with minimum 600 psi rating. Valve shall contain glass filled ball insert capable of providing equal percentage flow. Valves shall have allowable media temperature of 20 Deg F to 250 Deg F.
 - d.. Rating: Minimum 100 psi close off on 2 way valves and 70 psi on 3 way valves.
 - e. Medium: Valves shall be used with hot water or cold water with up to 50% glycol.
6. Sizing:
 - a. Minimum 100 psi close off on 2 way valves and 70 psi on three way valves
 - b. Maximum differential shall be 35 psi to ensure quiet operation.
 - c. Flow Characteristics: 2 way vales shall have equal percentage characteristics. 3 way valves shall have an equal percentage characteristic through the control port and a linear characteristic through the bypass port.
 - d. Butterfly Valves: 200 psig. maximum pressure differential, ASTM A 126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals.
 - e. Body Style: Wafer, Lug, or Groove
 - f. Disc Type: Nickel-plated ductile iron, Aluminum bronze, Elastomer-coated ductile iron, Epoxy-coated ductile iron.
 - g. Sizing: 1 psig. maximum pressure drop at design flow rate.
7. Terminal Unit Control Valves: 360 psi forged yellow brass body, nickel plated brass ball, with optimizer insert for modulating applications, blow-out resistant stem, two or three-port as indicated, and threaded ends for chilled or hot water, up to 50% glycol solutions. Actuators shall be as noted above with 5 year warranty. Spring return is required for all Unit Ventilator heating valves and other terminal equipment that has an outside air source. All non-spring return valves must have manual override ability built in to the actuator.
 - a. Rating: ANSI class IV, maximum static pressure of 250 psig., minimum fluid temperature of 20°F and maximum of 250°F operating conditions.
 - b. Sizing: 4 psig. maximum pressure drop at design flow rate, to close against pump shutoff head.
 - c. Flow Characteristics: Two-way and three-valves shall have equal percentage characteristics.
8. Actuation: Valve actuators shall be selected to provide proper control, and close-off as required by the application. All valves with actuators larger than six square inch effective area shall be provided with position indication.

C. Control Dampers

1. The BMS Contractor shall furnish all automatic dampers. All automatic dampers shall be sized for the application by the BMS Contractor or as specifically indicated on the Drawings.

2. All dampers used for throttling airflow shall be of the opposed blade type arranged for normally open or normally closed operation, as required. The damper is to be sized so that, when wide open, the pressure drop is a sufficient amount of its close-off pressure drop to shift the characteristic curve to near linear.
3. All dampers used for two-position, open/close control shall be parallel blade type arranged for normally open or closed operation, as required.
4. Damper frames and blades shall be constructed of either galvanized steel or aluminum. Maximum blade length in any section shall be 60". Damper blades shall be 16-gauge minimum and shall not exceed eight (8) inches in width. Damper frames shall be 16-gauge minimum hat channel type with corner bracing. All damper bearings shall be made of reinforced nylon, stainless steel or oil-impregnated bronze. Dampers shall be tight closing, low leakage type, with synthetic elastomer seals on the blade edges and flexible stainless steel side seals. Dampers of 48"x48" size shall not leak in excess of 8.0 cfm per square foot when closed against 4" w.g. static pressure when tested in accordance with AMCA Std. 500.
5. Airfoil blade dampers of double skin construction with linkage out of the air stream shall be used whenever the damper face velocity exceeds 1500 FPM or system pressure exceeds 2.5" w.g., but no more than 4000 FPM or 6" w.g. Acceptable manufacturers are Johnson Controls D-7250 D-1250 or D-1300, Ruskin CD50, Vent Products 5650, or equivalent as manufactured by Honeywell or Siemens.
6. One piece rolled blade dampers with exposed or concealed linkage may be used with face velocities of 1500 FPM or below. Acceptable manufacturers are: Johnson Controls D-1600, Ruskin CD36, Vent Products 5800, or equivalent as manufactured by Honeywell or Siemens.
7. Multiple section dampers may be jack-shafted to allow mounting of piston pneumatic actuators and direct connect electronic actuators. Each end of the jackshaft shall receive at least one actuator to reduce jackshaft twist.

D. Control Relays

1. Control Pilot Relays

- a. Control pilot relays shall be of a modular plug-in design with retaining springs or clips.
- b. Mounting Bases shall be snap-mount.
- c. DPDT, 3PDT, or 4PDT relays shall be provided, as appropriate for application.
- d. Contacts shall be rated for 10 amps at 120VAC.
- e. Relays shall have an integral indicator light and check button.
- f. Acceptable manufacturers: Johnson Controls, Honeywell or Siemens

2.10 MISCELLANEOUS DEVICES

A. Local Control Panels

1. All control panels shall be factory constructed, incorporating the BMS manufacturer's standard designs and layouts. All control panels shall be UL inspected and listed as an assembly and carry a UL 508 label listing compliance. Control panels shall be fully enclosed, with perforated sub-panel, hinged door, and slotted flush latch.
2. In general, the control panels shall consist of the DDC controller(s), display module as specified and indicated on the plans, and I/O devices—such as relays, transducers, and so forth—that are not required to be located external to the control panel due to function. Where specified the display module shall be flush mounted in the panel face unless otherwise noted.
3. All panel wiring shall be to and from terminal strips. The use of wire nuts for connection of wiring to or from a common point is not acceptable.
4. All I/O connections on the DDC controller shall be provide via removable or fixed screw terminals.
5. Low and line voltage wiring shall be segregated. All provided terminal strips and wiring shall be UL listed, 300-volt service and provide adequate clearance for field wiring.

6. All wiring shall be neatly installed in plastic trays or tie-wrapped.
7. All wiring shall be identified.
8. A convenience 120 VAC duplex receptacle shall be provided in each enclosure, fused on/off power switch, and required transformers.

B. Power Supplies

1. DC power supplies shall be sized for the connected device load. Total rated load shall not exceed 75% of the rated capacity of the power supply.
2. Input: 120 VAC +10%, 60Hz.
3. Output: 24 VDC.
4. Line Regulation: +0.05% for 10% line change.
5. Load Regulation: +0.05% for 50% load change.
6. Ripple and Noise: 1 mV rms, 5 mV peak to peak.
7. An appropriately sized fuse and fuse block shall be provided and located next to the power supply.
8. A power disconnect switch shall be provided next to the power supply.

C. Thermostats

1. Electric room thermostats of the heavy-duty type shall be provided for unit heaters, cabinet unit heaters, and ventilation fans, where required. All these items shall be provided with concealed adjustment. Finish of covers for all room-type instruments shall match and, unless otherwise indicated or specified, covers shall be manufacturer's standard finish.

D. Thermostat, humidistat, and CO₂ Sensor Guards

1. All thermostats located in public and non supervised areas shall be fitted with tamperproof Lexan guards. Cast iron guards shall be provided for gymnasium, locker rooms.

PART 3 – PERFORMANCE / EXECUTION

3.1 BMS SPECIFIC REQUIREMENTS

A. Graphic Displays

1. Provide a color graphic system flow diagram display for each system with all points as indicated on the point list.
2. User shall access the various system schematics via a graphical penetration scheme and/or menu selection.
3. All setpoints, parameters, etc. designated as manually adjustable (i.e. adj.) in the sequences of operation shall be directly adjustable from the associated colorgraphic screen or a separate setpoint screen, the latter being directly accessible via a transfer point on the original colorgraphic screen. It shall not be necessary to leave the colorgraphic screen package in order to make the adjustments. **NO EXCEPTIONS.** Setpoint adjustment shall be a single step process (i.e. not require multiple save operations) and all setpoint changes shall be retained during power outages.
4. Alarm limit, setpoint and reset schedule values indicated in the specifications or sequences of operation are given as starting points only. Final values shall be established during the commissioning process and provided in hard copy documented format by the Controls Contractor as part of the O & M manual submission at project completion.

- B. The following graphical screens, as a minimum, shall be developed for this project. For each system or floor plan, the display shall contain the points identified in the point list (or available via the interface) as well as associated software points and allow for setpoint changes, overrides etc. Sequence of operation information, shop drawings and specification data sheets associated with a system shall be available from**

the colorgraphic screen associated with that system. This feature shall be fully implemented for the colorgraphic screens created for this project.

Main Screen

Building Overview with Floor Selection

Ground Floor Area A, thermographic floor plan with transfer to terminal units
Ground Floor Area B, thermographic floor plan with transfer to terminal units
Ground Floor Area C, thermographic floor plan with transfer to terminal units
Ground Floor Area D,E, thermographic floor plan with transfer to terminal units

First Floor Area B, thermographic floor plan with transfer to terminal units
First Floor Area C, thermographic floor plan with transfer to terminal units
First Floor Area F, thermographic floor plan with transfer to terminal units
First Floor Area G, thermographic floor plan with transfer to terminal units

Hot Water System

Hot Water System Setpoints

Chilled Water System

Chilled Water System Setpoints

AHU-1

AHU-2

AHU-3

AHU-4

AHU-5

AHU-6

AHU-7

AHU-8

AHU Setpoints (one screen per AHU)

RTAHU-2

RTAHU-3

RTAHU Setpoints (one screen per RTAHU)

RTU-1 thru 9

RTU setpoints (one screen)

RTU-10 (one screen)

RTU-11 (one screen)

Individual Unit Ventilators (one screen per unit ventilator)

Individual Fan Coil Units (one screen per fan coil unit)

Individual Heat Pump Units (one screen per heat pump unit)

Individual VVB Boxes (one screen per VVB box)

Stand Alone Fintube or Radiant Panels (one screen per location)

Exhaust Fans

OSS Schedules (one screen per zone)

OSS Schedule Overrides (one screen per zone)

Holiday Schedules

Miscellaneous

B. Custom Reports:

1. Provide custom reports as required for this project:

C. Actuation / Control Type

1. **Primary Equipment**

- a. Controls shall be provided by equipment manufacturer as specified herein.
- b. All damper and valve actuation shall be electric.

2. Terminal Equipment

- a. All terminal equipment shall be controlled with a HVAC-DDC Controller
- b. All damper and valve actuation shall be electric.

- D. The Controls Contractor shall meet with the owner to determine routing requirements for all alarm information. Particular attention shall be paid to developing a routing procedure that prevents non-critical alarms from impacting critical system operation. The prioritization and routing shall be fully implemented to the satisfaction of the owner.

3.2 INSTALLATION PRACTICES

A. Existing ATC System DEMO

1. The BMS subcontractor shall coordinate the existing control system demolition with the work of all the other trades. All portions of the facility that are to remain operational shall have their control systems left intact and operational until that specific phase is due for remodeling. Any controls, tubing and/or wiring that were demolished prematurely, shall be placed back into operation by this subcontractor until the area served is to be remodeled. The BMS subcontractor shall demo any/all existing control items, wiring, tubing and etc. that the other trades have not already demolished during the performance of their work. The BMS subcontractor shall perform all cutting, patching and painting as required for the removal of the existing control system. Any existing HVAC equipment to remain shall be tied into the new BMS system as required.

B. BMS Wiring

1. All conduit, wiring, accessories and wiring connections required for the installation of the Building Management System, as herein specified, shall be provided by the BMS Contractor unless specifically shown on the Electrical Drawings under Division 26 Electrical. All wiring shall comply with the requirements of applicable portions of Division 26 and all local and national electric codes, unless specified otherwise in this section.
2. All conduit, fittings, hangers and accessories for control wiring installed under the HVAC Contract shall conform to the levels of quality specified under Division 26.
3. All wiring shall be installed in conduit, and conduit shall be concealed in finished areas, except as hereinafter specified. Power or interlock wiring shall be run in separate conduit from sensor wiring.
4. All new construction thermostat drops shall be installed utilizing conduit with an electrical wall box installed within the wall construction. NO EXCEPTIONS. All wall thermostats, CO₂ sensors, room humidistats, and wall sensors located in classrooms, offices and lounges shall be mounted with centerline 4'-0" above the finished floor to comply with ADA mounting height requirements. All thermostats, CO₂ sensors, humidistats, and other wall sensors located in restrooms, corridors and other public areas shall be mounted with centerline 7'-0" above the finished floor
5. All low voltage conductors shall be types as herein indicated. Other types and sizes required by the temperature control manufacturer shall be submitted for approval. Low voltage two conductor wire shall be black twisted (six turns per foot) 16 AWG or 18 AWG wire, as indicated, 1/32, 80 degrees C., 600 volt PVC insulation. Low voltage three conductor wire shall be red, yellow, blue twisted (six turns per foot) 16 AWG or 18 AWG wire as indicated, 1/32, 80 degrees C., 600 volt PVC insulation. Cable shall be as manufactured by Alpha Wire Company, Belden Wire Company, Standard Wire and Cable or approved equal.

6. All control wiring outside of control panels shall be run in rigid conduit or EMT, except as hereinafter specified, and installed in strict accordance with the requirements of The National Electrical Code. Wiring for the control system, except the low voltage conductors, shall be single conductor solid or stranded copper not less than No. 14 AWG, with 600 volt Type THHN insulation, except where the manufacturer requires special types and sizes. Flameproof insulation shall be used where required by the NEC. Wiring for DDC system inputs/outputs shall be No. 18 two conductor with shield installed in accordance with the requirements of The National Electrical Code. Wiring for DDC system communication trunk shall be 2 conductor, 24AWG, stranded shielded low capacitance cable. All wiring in panel construction may be No. 16 or No. 18 AWG copper as recommended by the manufacturer provided same is properly protected and/or is in accordance with the NEC. No temperature control wiring installed under this contract shall be installed in the building lighting and power circuit systems. Communication trunk wiring shall not be installed in raceway and/or enclosures containing Class 1 or other Class 2 wiring.
7. The use of plenum rated cable above concealed accessible locations shall be permitted.
- C. All sensing elements located in water lines or tanks shall be provided with stainless steel separable sockets. The BMS Contractor shall select the proper location for each separable well. Sensing elements installed in ducts shall be securely anchored, and when long or averaging sensing elements are used the elements shall be strung through the duct to ensure representative cross sectional sampling
- D. All BMS panels and input/output interface panels shall be identified with black laminated plastic nameplates with white lettering. Panel identification shall be such that it can be easily cross referenced with as-built drawings. All items of equipment within input/output interface panels shall be labeled with an identification that corresponds with as-built drawings. All items mounted on the face of input/output interface panels shall be identified with black laminated plastic nameplates with white lettering. Identification shall include function and position information where applicable. All field devices shall be identified with black laminated plastic nameplates with white lettering secured with either double-backed tape or metallic strapping. Identification shall be same tag symbol as found on the as-built drawings.
- E. The ATC Contractor shall provide software to be loaded on the Balancing Contractor's computer for use in balancing the VAV system. The Balancing Contractor shall be responsible for delivering his computer to the ATC Contractor's office to have the software loaded and at the same time receive training on proper use of the software package. During the project, the ATC Contractor shall provide additional telephone support to the Balancing Contractor on proper use of the software package. At the end of the project, the Balancing Contractor shall be responsible for delivering his computer back to the ATC Contractor's office to have the balancing software deleted.
- F. In addition to any balancing and/or start-up assistance specified elsewhere in this section of the specifications, the ATC Contractor shall include in his bid two (2) days of on-site technician time to aid the Balancing Contractor in using the DDC system to configure required modes of operation for testing purposes. This time shall be consumed in full day increments, not necessarily concurrent, and must be scheduled with the ATC Contractor a minimum of one (1) week in advance of the actual need date. Should the Balancing Contractor require additional assistance, he shall be responsible for compensating the ATC Contractor on a time-and-material basis.

3.3 START-UP AND CHECK-OUT PROCEDURES

- A. The ATC Contractor shall be responsible for developing test plans and procedures to establish that the ATC system functions as described in the Sequence of Operations. The methodology shall address the observations, measurements, adjustments, calibrations and corrections necessary to accomplish the commissioning process. A detailed item-by-item procedure shall be followed for each item of HVAC equipment. Forms used by the ATC Contractor to record the results of the start-up and check-out procedures shall be available for review by the Professional and the owner.

- B. The procedures followed shall, as a minimum, incorporate the intent of the following guidelines:
1. Where weather-dependent procedures are checked by simulation, the Contractor shall also verify the actual results in the appropriate weather condition and/or season.
 2. Signals used to change the mode of unit operation shall originate from the actual control device intended for that purpose. Simulation may be used to cause the mode to change. All relay contacts, indicating lights and so on shall be checked for proper functioning with each operational mode change signal.
 3. All sensing elements and transmitters shall have an accuracy check of their calibration performed by comparing the ATC panel level readout with the actual value of the variable measured at the sensing element/transmitter location. All test instruments shall be traceable to NBS standards. Multiple comparisons shall be required for averaging-type sensing elements.
 4. Each HVAC system shall first be observed in the shutdown condition. The HVAC control panel shall be checked for power availability and dampers and valves shall be checked for normal position. Proper operation of all actuators and positioners shall also be checked while the HVAC system is in the shutdown condition. The control signal shall be varied from one extreme to the other and actuator travel from zero stroke to full stroke shall be verified. In addition, it shall be verified that the actuator moves the connected device in the proper direction from one extreme position to the other.
 5. Unit operation shall then be verified in the warm-up/cool-down mode, the occupied mode and the unoccupied mode, as well as during transition between modes. Proper damper and valve position shall be verified during each mode and proper operation of the control loop(s) shall be demonstrated by slightly changing controller inputs, outputs and/or setpoints. Proper operation of sensors used for night setback/setup operation shall be verified by changing setpoints and observing proper unit operation as previously described.
 6. Differential pressure switch, current switch, freezestat, firestat and smoke detector operation shall be verified via simulation while the associated unit is running. Simulation shall be accomplished without any false alarms to the Life Safety system. Proper contact output at the DDC panel location shall be verified for all hardware simulation. In addition, proper control device actions and interlock functions as described in the Sequences of Operation shall be verified. Proper system operation shall also be verified as the devices are reset.
- C. Where Maintenance Time Reminders, Change-of-State Alarms, Analog Limit Alarms, etc. are to be provided, the ATC Contractor shall verify that each message is sent to the appropriate output device whenever the trigger condition occurs.
- D. Where colorgraphics are being provided, the ATC Contractor shall verify that all links from dynamic point displays to the actual hardware and software points are correct. This verification shall involve using each colorgraphic screen to make all setpoint changes, schedule overrides, control overrides etc. and verify that the appropriate changes to the control hardware and panel databases take place.
- E. Where implemented trends at the panel level and/or the HMI computer level are to be provided, the ATC Contractor shall demonstrate successful implementation via actual printout of the data being gathered in the case of panel trends, and display, archiving and printout of trend data being gathered at the HMI level.

3.4 TRAINING

- A. ATC Contractor shall provide 40 Hours of on-site training, broken down into 4-hour sessions, by a system technician who is fully knowledgeable of the specific installation details of the project. This training shall be "hands' on" type. A mutual agreement on the scheduling of this training class will be made between the Owner and the ATC Contractor. The intent of this training is that 20 hours will occur before the Owner has accepted the project and the rest is to follow shortly thereafter.
- B. The training class will use the actual Operator & Maintenance manual that will be submitted for this project.
- C. As a minimum, this training will cover the following topics:
 - 1. System Overview
 - a. Architecture and Function
 - 2. System Operation
 - a. System Access
 - b. Operation Monitoring
 - c. Exception Reporting and Acknowledge
 - d. Operation Override
 - e. Scheduling
 - f. Editing Programmed Variables
- D. The training class will cover topics in a "hands-on" mode.
- E. Proper and adequate documentation must be provided, this will include:
 - 1. Accurate as-built drawings and sequences submitted in hard copy and electronic form (the electronic form can be easily updated via a standard Computer Aided Drafted (CAD) program).
 - 2. Technical specification sheets
 - 3. Signed software license agreement (as required)
 - 4. Operator & Maintenance (O & M) manuals
 - 5. Warranty statement

3.5 WARRANTY

- A. The local field office shall warranty all BMS computers and related I/O equipment and all new pneumatic and electric hardware for a period of one year following Owner acceptance of the system.
- B. All equipment found to have defects in material or workmanship during this warranty period shall be replaced at no charge to the Owner with equipment of equal type and quality by the BMS manufacturer. All labor required during the warranty period shall also be included, with the following clarification. Materials furnished but not installed by the BMS contractor shall be covered to the extent of the product only. Installation labor shall be the responsibility of the trade contractor performing the installation
- C. Operator workstation software, project-specific software, graphic software (where specified), database software, and firmware updates which resolve known software deficiencies as identified by the BMS Contractor shall be provided to the Owner at no charge during the warranty period.
- D. The BMS Contractor's office shall be within a 100 mile radius of the jobsite.

- E. The BMS Contractor shall respond to the job site within a 24 hour period for any warranty work relating to the control system.

3.6 WARRANTY ACCESS

- A. The Owner shall grant to the Contractor, reasonable access to the BMS system during the warranty period. The Owner shall provide, at no cost to the Contractor, a public IP address for the Workstation Server Hardware Station for remote telecommunication during this period.
- B. Internet connection shall provide the following functions:
 - 1. Access to the entire facility control system by the Contractor to provide service and diagnostic support.
 - 2. Access by the Owner from off-site for similar purposes, and for remote operation, monitoring, and adjustment of facility functions.
 - 3. Complete remote access to all programming tools
 - 4. Auto email notification of desired alarms to a remote site.

3.7 APPLICATION DEVELOPMENT AND REVIEW

- A. The control specifications and the sequences of operation are for conveying general concept only and are not meant to be inclusive of all hardware requirements or all functional sequence requirements. Refer to the complete package of contract drawings for equipment quantity and location information. Items mentioned in Section 230900, mentioned in the sequences of operation or shown on other HVAC drawings shall become part of the work of this project without the necessity of being separately detailed in each of those applicable sections of the contract documents. Reference in one section of the contract documents shall be interpreted to include reference in all other applicable sections. Any additional hardware and/or software required to accomplish functional intent shall be provided (without additional cost to the owner) just as though it were fully detailed on the contract documents.
- B. The ATC Contractor shall be responsible for providing complete detailed sequences of operation for each piece of equipment or system regardless of the completeness and clarity of the sequences in the contract documents. These detailed sequences shall address all operating modes including, but not limited to, normal failure, failure recovery. These detailed sequences shall also address all system interaction and operational interfaces and shall be required prior to beginning implementation of the application software and MMI package. The sequences of operation as written infer certain additional functionality in order to accomplish project intent. With that in mind, software review meetings shall be held with the Engineer, Owner, Commissioning Agent and Control Contractor to finalize details prior to beginning implementation of the application software and MMI package and again at regular intervals during initial operation of the system. Following is a summary of anticipated review meetings and required follow-up actions by the Control Contractor.
 - 1. Review scope of software to be implemented. This shall be an interchange of ideas and operating characteristics of the equipment and facility. All data relative to system operations and design criteria shall be presented at this time. The Control Contractor shall gather this data and structure the required software around this information. This shall occur prior to starting any software programming by the control installer. This meeting shall also establish the system and point naming conventions to be used throughout the project by the Control Contractor. Naming conventions shall be approved by the Engineer and the Owner. Colorgraphic screens hierarchy, layout, functionality and operator interaction, including alarming and trending, shall be presented for approval by the Engineer and the Owner.
 - 2. After one (1) to three (3) months of cooling system operation, as deemed appropriate by any party, an operations/software review shall be held. Any changes required shall be implemented by the Control Contractor after this meeting.

3. Prior to the beginning of the next cooling season, a final software review shall be held to review the operational sequences, resolve any issues that may have occurred and/or implement desired software changes to enhance the system operation.
4. After one (1) to three (3) months of heating system operation, as deemed appropriate by any party, an operations/software review shall be held. Any changes required shall be implemented by the Control Contractor after this meeting.
5. Prior to the beginning of the next heating season, a final software review shall be held to review the operational sequences, resolve any issues that may have occurred and/or implement desired software changes to enhance the system operation.
6. Final software reviews shall be held for each system to review the operational sequences, resolve any issues that may have occurred and/or implement desired software changes to enhance the system operation.

END OF SECTION 230900

SECTION 230993 – SEQUENCE OF OPERATION FOR HVAC CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

PART 2 – PRODUCTS

NOT APPLICABLE

PART 3 – EXECUTION

3.1 SEQUENCE OF OPERATION

A. OCCUPIED/UNOCCUPIED CHANGEOVER

1. The DDC system shall provide warm-up/occupied/unoccupied changeover for the zones indicated below. Zone temperature sensors shall function to provide representative space temperature information for each zone to the DDC system. The DDC system shall optimize changeover times based on zone temperature. Each zone shall be provided with its own discrete optimization program. Exhaust fans shall not be energized until Occupied time. Zoning scheme shall be approved by the Owner prior to implementation of any application programming by the ATC Contractor.
 - a. basement
 - b. first floor
 - c. second floor
 - d. third floor
 - e. fourth floor
 - f. fifth floor
 - g. sixth floor
 - h. seventh floor
 - i. eighth floor
2. The DDC system shall include provisions, on a per zone basis, for the user to enter an override time interval which will cause the zone to operate in the occupied mode when it was otherwise scheduled to be in the unoccupied mode.
3. In addition to providing the ability to schedule the zones individually, the ATC Contractor shall provide the ability to schedule the entire building from a single schedule. The BMS operator will provide a manual input to the BMS to select between individual and global scheduling options.

B. OPTIMUM START/STOP

1. Optimum Start - Heating Mode

- a. When the outside air temperature is less than the heating changeover temperature and the space temperature is below the occupied heating setpoint, the OSS program shall control in the heating mode.

- b. Beginning at the maximum start time, OSS shall calculate the time required to bring the controlled space up to the occupied heating setpoint.
 - c. At the calculated start time, the DDC System shall switch the appropriate zone to the occupied mode.
 2. Optimum Stop - Heating Mode
 - a. At the scheduled vacancy time less the maximum programmed stop time limit, the OSS program shall calculate the heating stop time.
 - b. At the calculated heating stop time, the DDC System shall switch the appropriate zone to the Unoccupied Mode.
 3. Optimum Start - Cooling Mode
 - a. When the outside air temperature is greater than the cooling changeover temperature and the space temperature is above the occupied cooling setpoint, the OSS program shall control in the cooling mode.
 - b. Beginning at the maximum start time, OSS shall calculate the time required to bring the controlled space down to the occupied cooling setpoint.
 - c. At the calculated start time, the DDC System shall switch the appropriate zone to the occupied mode.
 4. Optimum Stop - Cooling Mode
 - a. At the scheduled vacancy time less the maximum programmed stop time limit, the OSS program shall calculate the cooling stop time.
 - b. At the calculated cooling stop time, the DDC System shall switch the appropriate zone to the Unoccupied Mode.
 5. OSS Adaptive Operation
 - a. The OSS program shall monitor its heating and cooling performance for each cycle of operation.
 - b. Using data obtained during start up, the OSS adaptation program shall modify the OSS operating tables to correct for any errors that may occur, and adapt the building's OSS program to the building's mass and thermal characteristics.
 - c. Separate calculations and tables shall be maintained for Optimum Start Heat, Optimum Start Cool, Optimum Stop Heat and Optimum Stop Cool.

C. SPECIAL SEQUENCE REQUIREMENTS

1. Control algorithms shall incorporate software to automatically limit damper (and control valve) travel based on outdoor air temperature. As the outdoor air temperature changes, the software shall dynamically adjust/reset damper (and control valve) travel limits in order to provide for tighter control. As an example, all air handling unit control algorithms shall include a feature to reduce the amount that the outdoor air damper can open (i.e. move toward the full open position) as the outdoor air temperature drops below 40 DEGF (adj.).

2. Space mounted CO2 detectors shall be furnished and installed for auditorium, gymnasium, auxiliary gymnasium, fitness room and cafeteria areas. CO2 detectors through the DDC system shall function to modulate the outdoor air dampers to the open position, overriding minimum outdoor air damper positions, in order to maintain space CO2 levels at setpoint during the occupied mode. During the unoccupied mode the CO2 detectors shall have no impact on the respective mechanical system operation.
3. Several sequences hereinafter indicate that a manual override switch (depress for 3 seconds) on the room sensor will activate the occupied mode for a period of one hour (adj.). Locations where this override function is to be provided shall be designated and approved by the Owner prior to implementation of any application programming by the ATC Contractor.
4. All setpoints, parameters, etc. designated as manually adjustable (i.e. adj.) in the following paragraphs shall be directly adjustable from the colorgraphics. The associated colorgraphic screen or a separate setpoint screen, the latter being directly accessible via a transfer point on the original colorgraphic screen or from a tree structure, shall provide for the adjustment function. It shall not be necessary to leave the colorgraphic screen package in order to make the adjustments. NO EXCEPTIONS
5. Occupancy Sensor Input: Occupancy Sensors with an auxiliary contact for use by the BMS system shall be installed as a part of the lighting control system under the electrical portion of this project. The BMS subcontractor shall furnish and install wiring (and conduit where required) between the auxiliary contact and the BMS DDC controller. The contacts shall make when space occupancy is detected, and via the BMS, place the mechanical equipment serving the area into the occupied mode of operation. When the occupancy sensor contacts open, the mechanical equipment serving the area shall be placed into an unoccupied mode of operation. During the zone occupied cycle, as determined by the zone optimum start/stop schedule, loss of occupancy status as determined by the occupancy sensor shall cause the DDC controller to implement the standby setpoint strategy and OA reduction (typically a setpoint somewhere between typical occupied and unoccupied values) for the particular space involved.

The occupancy sensor will be locked out during the unoccupied mode as determined by the OSS program. Only operation of the override pushbutton shall function to return the equipment to the occupied mode.

6. Hardware safeties (freezestat., firestat, high/low static, smoke detector, etc.) shall be auto reset type. DDC controller software shall include provisions to automatically restart equipment after alarm condition clears. In addition, controller software shall lock-out auto restart capability after a safety trips 3 (adj.) times in a 12 hour period. Auto restart capability lock-out shall be alarmed at the central operator workstation as well as text messaged to designated owner personnel.
7. Hardware safeties (freezestat., firestat, high/low static, smoke detector, etc.) shall be hardwired to their associated starter, VFD, etc. The hardware terminal device shall include an auxiliary set of contacts for input of alarm condition to the DDC system. Hardware safety alarm trips shall be alarmed at the central operator workstation as well as text messaged to designated owner personnel.

D. HOT WATER SYSTEM

1. The hot water system shall be started and stopped automatically based on outdoor air temperature (60 degF, adj.), or manually (via DI override), through the DDC system. The DDC system shall automatically start and stop the duplex hot water circulating pump system. In the absence of operator selection (via logic blocks) of the lead pump, the DDC system shall automatically provide lead/lag operation for the duplex pumping system. When an accumulated run time of 300 hours (adj.) is reached for the lead pump, the control system shall automatically switch the previous lag

unit to be the current lead unit until the run hours limit is reached. Once selected for automatic operation, the DDC system shall start the lead hot water pump. A software override provision shall be incorporated to allow the operator to designate a specific pump as lead for a given period of time regardless of the 300 hour (adj.) changeover interval

2. A current switch across each pump shall provide pump proof of operation. Should the lead pump fail, the control system shall automatically energize the lag pump after an adjustable time delay. Pilot lights shall be provided on the face of the panel to indicate pump failure and normal operation. An alarm shall be sent to the Operator Workstation and paging system upon pump failure verification.
3. Upon proof of pump operation, two (2) differential pressure transducers located 2/3 down the piping system shall be used to vary pump speed to maintain a remote differential setpoint of 10 psig (adj.), or as determined by the balancing contractor. The colorgraphics package shall include a provision for allowing the operator to select worst case or average differential pressure as the input to the control algorithm for the main loop circulating pump.
4. Software provisions shall be incorporated to allow the operator to designate the hot water system to be disabled during a specific interval of time (i.e. the summer months) regardless of outdoor air temperature.
5. The heating system consists of one (1) steam to water heat exchanger (primary heating) and one (1) hot water boiler (summer heating).
6. Steam to Hot Water Heat Exchanger (Primary Heat during the Winter)

The heat exchanger – hot water heating system consists of a steam/hot water exchanger with two (2) hot water pumps.

- **Heat Exchanger and Hot Water Pump Control**

The hot water supply temperature shall be reset inversely from the outdoor air temperature as follows (All suggested set points and settings are adjustable):

OUTDOOR – AIR	HOT WATER SUPPLY
00°	190°
60°	110°

A local digital controller coordinating signals from outdoor air and hot water supply temperature sensors shall accomplish the reset schedule. As the demand for hot water increases the digital controller shall modulate the steam valves (1/3 capacity and 2/3 capacity) in the following manner:

- a. Modulate the 1/3 capacity valve from closed to full open.
- b. Modulate the 2/3 capacity valve from closed to 40% open while modulating the 1/3 capacity valve from full open to closed.
- c. Modulate the 2/3 capacity valve from 40% open to 100% open.
- d. Modulate the 1/3 capacity valve from closed to full open.

The reverse sequence shall occur as the demand for hot water decreases.

When the outdoor air is above 70° (adj) the heat exchanger steam valves shall close and the summer boiler shall be enabled to run. Heat exchanger valves shall close whenever the hot water pump stops (automatically and/or manually). A system alarm shall be sent to the main campus automation system if the pump is manually indexed "On" and/or "Off".

PROJECT POINTS

Ao—Analog Out – 1/3 capacity steam valve control
Ao—Analog Out – 2/3 capacity steam valve control
Ai—Analog In ----Hot Water Supply Temperature
Ai—Analog In-----Hot Water Return Temperature

7. Summer Boiler – System Hot Water Control

The BAS shall give and receive signals to/from the boiler supplier provided “cycle minimizer”, as per the following point matrix, to begin making hot water. All reset shall be accomplished through the boiler controls. ATC contractor shall control main circulating pumps directly and report parameters to the “cycle minimizer”.

The heating system consists of one (1) hot water boiler and associated isolation valves.

The isolation valves will be located on floors 2-6 and will be closed (bypass fan coils) when the summer boiler is enabled. The valves shall revert back to normal position or open when the summer boiler is disabled.

Furnish and install a digital control panel in the mechanical equipment room for operation of the equipment noted above. The DDC panel shall include an operator’s display for system access and information display. The boiler and the pumps shall be enabled to operate on via BAS schedule. Once enabled, the boiler shall operate and be sequenced as noted below:

The boiler hot water temperature shall be reset from outdoor air to maintain a reset schedule. The schedule shall be 180° F. at 0° F. and 100° F. at 60° F. Temperature shall be maintained by staging the boiler from low fire to high fire. All firing and reset control shall be accomplished by the Boiler’s own control panel (“Cycle Minimizer”)

Boiler shall be controlled as follows:

Start lead pump
Prove Status of Pump Operation
Prove status of flow thru Boiler
Start boiler at Low Fire and modulate to high fire to maintain hot water supply temperature setpoint as set by the reset schedule.

The reverse sequence shall occur as the demand decreases.

8. Emergency Shutdown System: ATC Contractor shall furnish and install at each internal and external door exit from the boiler room, a break glass push button station equal to Allen-Bradley Bulletin 800T-NX114. Station shall have bright red finish, hammer with attaching chain and name plate reading "TO OPERATE, BREAK GLASS TO STOP BOILER". The break glass stations shall be series wired to a new multi-pole relay in NEMA 1 enclosure. The relay contacts shall be wired into the burner limit circuit of the new boiler(s), existing boiler (where appropriate) and domestic water heater. An additional relay contact shall close to energize an Edwards No. 52 AdaptaBeacon with rotating light in an amber color lens. Beacon shall be mounted near the ceiling at a point relatively common to all equipment. This beacon will alert operator that multi-pole relay is de-energized. All hardware and interlock wiring shall be provided by the ATC Contractor.
9. Multi-pole relay shall also include a set of contacts for monitoring by the DDC system. An alarm shall be generated at the BAS whenever the emergency shutdown system is activated.

- AI - Outdoor Air Temperature
- DO - Hot Water Pump #1 Start/Stop *
- DI - Hot Water Pump #1 Status ~
- AO - Hot Water Pump #1 Speed Control
- DI - Hot Water Pump #1 VSD Run Status
- DI - Hot Water Pump #1 VSD Alarm Status ~
- DO - Hot Water Pump #2 Start/Stop *
- DI - Hot Water Pump #2 Status ~
- AO - Hot Water Pump #2 Speed Control
- DI - Hot Water Pump #2 VSD Run Status
- DI - Hot Water Pump #2 VSD Alarm Status ~
- AI - Hot Water System Differential Pressure

**BOILER AND HOT WATER SYSTEMS POINTS MATRIX BETWEEN BMS AND BOILER
 CYCLE MINIMIZER**

BMS SYSTEM OBJECTS		BOILER SYSTEM OBJECTS				
I	TY	ACCESS TYPE	GENERAL POINT DESCRIPTION	Active/Inactive or UNITS	T	ACCESS TYPE
1	AI	Write	Outdoor Air Temperature	Degrees F.	A	Read
2	BO	Write	Heating System On or Off	On/Off	B	Commandable
3	A	Read	Building Hot Water Return Temperature	Degrees F.	A	Write
4	A	Read	Boiler Loop Hot Water Supply Temperature	Degrees F.	A	Write
5	A	Read	Building Hot Water Supply Temperature	Degrees F.	A	Write
6	A	Read	Hot Water Supply Temperature Set Point	Degrees F.	A	Write
7	A	Read	Boiler #1 Hot Water Supply Temperature	Degrees F.	A	Write
8	A	Read	Boiler #2 Hot Water Supply Temperature	Degrees F.	A	Write
9	BV	Read	Boiler #1 Enabled/Disabled	Enabled/Disabled	B	Write
1	BV	Read	Boiler #1 Status	On/Off	B	Write
1	A	Read	Boiler #1 Firing Percentage	Percent	A	Write
1	BV	Read	Boiler #1 Fuel Valve Status	Open/Closed	B	Write

1	BV	Read	Boiler #1 Down on Failure	Normal/Alarm	B	Write
1	BV	Read	Boiler #1 Flame Failure	Normal/Alarm	B	Write
1	BV	Read	Boiler #1 Lead	Lead	B	Write
1	BV	Read	Boiler #1 Lag	Lag	B	Write
1	BV	Read	Boiler #2 Enabled/Disabled	Enabled/Disabled	B	Write
1	BV	Read	Boiler #2 Status	On/Off	B	Write
1	A	Read	Boiler #2 Firing Percentage	Percent	A	Write
2	BV	Read	Boiler #2 Fuel Valve Status	Open/Closed	B	Write
2	BV	Read	Boiler #2 Down on Failure	Normal/Alarm	B	Write
2	BV	Read	Boiler #2 Flame Failure	Normal/Alarm	B	Write
2	BV	Read	Boiler #2 Lead	Lead	B	Write
2	BV	Read	Boiler #2 Lag	Lag	B	Write
2	BV	Write	Occupied Reset Schedule Required	On/NA	B	Commandable
2	BV	Write	Unoccupied Reset Schedule Required	On/NA	B	Commandable
2	BV	Write	Reheat Rest Schedule Required	On/NA	B	Commandable
2	BO	Write	Hot water Pump #1 Start/Stop	On/Off	B	Read
2	BI	Write	Hot Water Pump #1 Status	On/Off	B	Read
3	A	Write	Hot Water Pump #1 Speed Control	Percent	A	Read
3	BO	Write	Hot Water Pump #2 Start/Stop	On/Off	B	Read
3	BI	Write	Hot Water Pump #2 Status	On/Off	B	Read
3	A	Write	Hot Water Pump #2 Speed Control	Percent	A	Read
3	AI	Write	Hot Water System Remote Differential Pressure	PSI	A	Read
3	AI	Write	Hot Water System Differential Set Point	PSI	A	Read

E. CHILLED WATER SYSTEM CONTROL

1. The chilled water system shall consist of one (1) water to water exchanger along with two (2) variable speed chilled water pumps.
2. Furnish and install a digital control panel in the mechanical equipment room for operation of the equipment noted above. The DDC panel shall include an operator's display for system access and information display. The pumps shall be enabled to operate on via BAS schedule. Once enabled, the water to water exchanger shall operate and be sequenced as noted below:

The plant side chilled water valve on the campus loop system shall modulate to maintain a building chilled water return temperature setpoint of 53 degrees. If the return chilled water temperature drops below 50 or rises above 56 degrees, alarm head end controller.

The chilled water pumps shall operate in a lead/lag manner and be controlled via a differential pressure sensor located 2/3 down the longest straight pipe available. These pumps shall operate when the outdoor air is above 70(Adj) degrees. Pilot lights shall be provided on the face of the panel to indicate pump failure and normal operation. When the lead pump fails as sensed by a current sensing relay the lag pump shall start and an alarm shall be generated to the head end controller.

3. The chilled system shall be started and stopped automatically based on outdoor air temperature and building (zone) occupancy cycle, or manually (via DI override), through the DDC system. Software provisions shall be incorporated to allow the operator to designate the chilled water system to be disabled during a specific interval of time (i.e. the winter months) regardless of the outdoor air temperature. Chilled water flow shall be variable volume and condenser water flow shall be constant volume.
4. In the absence of operator selection (via logic blocks) of the lead pump, the DDC system shall automatically provide lead/lag operation for the duplex pumping system. When an accumulated run time of 300 hours (adj.) is reached for the lead pump, the control system shall automatically switch the previous lag unit to be the current lead unit until the run hours limit is reached. Once selected for automatic operation, the DDC system shall start the lead chilled water pump and the lead condenser water pump before starting the chiller. A current switch across each pump shall provide pump proof of operation. Should the lead pump fail, the control system shall automatically energize the lag pump after an adjustable time delay. A software override provision shall be incorporated to allow the operator to designate a specific pump as lead for a given period of time regardless of the 300 hour (adj.) changeover interval.
5. If a pump current switch should fail to energize, indicating a lack of pump operation the pumps shall be deenergized, and an alarm shall be sent to the Operator Workstation and paging system.
6. Software provisions shall be incorporated to allow the operator to designate the chilled water system to be disabled during a specific interval of time (i.e. the winter months) regardless of the outdoor air temperature.
7. Whenever the outdoor air temperature drops below 35 degF (adj.), the DDC system shall start and run the chilled water pump at lowest speed for freeze protection. The DDC system shall position the chilled water valves as required for this freeze protection mode.

8. Provide a read-out indication at the DDC panel for: The chilled water supply and return temperatures, loop supply and return temperature, and the status of the system, i.e. cool-off.

DO - Chiller Enable/Disable
DI - Chiller Run Status
DI - Chiller Alarm Status ~
AO - Chiller Supply Water Reset
AO - Chiller Demand Limit Setpoint Adjust
DO - Chilled Water Pump #1 Start/Stop *
DI - Chilled Water Pump #1 Status ~
AO - Chilled Water Pump #1 Speed Control
DI - Chilled Water Pump #1 VSD Run Status
DI - Chilled Water Pump #1 VSD Alarm Status ~
DO - Chilled Water Pump #2 Start/Stop *
DI - Chilled Water Pump #2 Status ~
AO - Chilled Water Pump #2 Speed Control
DI - Chilled Water Pump #2 VSD Run Status
DI - Chilled Water Pump #2 VSD Alarm Status ~
AI - Chilled Water Supply Temperature ~
AI - Chilled Water Return Temperature
AI - Chilled Water System Differential Pressure #1
AI - Chilled Water System Differential Pressure #2
AI - Chilled Water Return FWH
AI - Chilled Water Bypass FWH

DO - Condenser Water Pump #1 Start/Stop *
DI - Condenser Water Pump #1 Status ~
DO - Condenser Water Pump #2 Start/Stop *
DI - Condenser Water Pump #2 Status ~
DO - Cooling Tower Fan Start/Stop *
DO - Cooling Tower Fan Status ~
AO - Cooling Tower Fan Speed Control
DI - Cooling Tower Fan VSD Run Status
DI - Cooling Tower Fan VSD Alarm Status ~
DI - Cooling Tower Vibration Alarm
AI - Condenser Water Supply Temperature ~
AI - Condenser Water Return Temperature

DI - Refrigerant Monitoring Panel Alarm
AI - Refrigerant Monitoring Level

Project Points

Ai=Analog In-----Bldg Chilled Water Supply Temperature
AI=Analog In-----Bldg Chilled Water Return Temperature
Ai=Analog In-----Chilled Water Differential Pressure Sensor (Typical of 2)
Ao=Analog Out----Lead Pump Speed
Ao=Analog Out----Lag Pump Speed
Ao=Analog Out----Primary Chilled Water Valve
Bo=Binary In-----Lead Pump Start/Stop
Bo=Binary In-----Lag Pump Start/Stop

Bi=Binary In-----Lead Pump Status Bi=Binary In-----Lag Pump Status

F. VAV Air Handler Unit

1. The heating and ventilation systems shall consist of a new variable volume air handling unit. The unit shall have Economizer dampers (outdoor air – return air – exhaust air), Supply fan, return fan, hot water, face/bypass, chilled water and associated controllers – sensors for maintaining a constant supply air temperature (55°F -60°F) which will be reset based on outdoor air. The economizer dampers shall be furnished with the Rooftop air handler.

Air Handling Unit Control

1. The system operates as follows (All suggested set points and settings are adjustable)
2. Johnson Controls shall furnish and install a digital controller for operation of the Variable Volume Air Handling Units. All units shall operate based upon a schedule.
3. Upon initial start-up the Variable Volume Unit/s shall operate as follows:
 - The supply air fan shall start with the outdoor air damper closed, return air damper open, exhaust air damper closed.
 - When the outdoor air is above 40 degrees the hot water coil shall modulate to maintain 60-degree discharge temperature and the face/bypass shall be full open. When the outdoor air is below 40 degrees the valves shall be open 100% and the face/bypass damper shall modulate to maintain discharge air setpoint.
 - Upon stabilization of system control processes, the system shall revert to total system operations as noted below.
 - Mixed air sensor modulates outdoor/return/exhaust (economizer) air dampers to maintain 55 degrees mixed air temperature.
 - As mixed air temperature drops and maximum outdoor air damper closes, the outdoor airflow station (furnished and installed by equipment manufacturer) shall maintain minimum fresh airflow to maintain ventilation requirements. A duct mounted CO2 sensor shall modulate the outdoor air damper from minimum airflow to maximum airflow to maintain 700 PPM (adj).
 - Air volume shall be controlled by modulating a VFD in response to static pressure sensors (2 as noted on the plans) mounted 2/3 downstream of the supply fan discharge. Duct static pressure shall be maintained at 1" W.G.
 - Economizer dampers shall revert to the Minimum outdoor airflow setting (and shall be monitored with the minimum air volume maintained) when the chilled water is enabled and the outdoor air temperature exceeds the return air temperature. The chilled water valve will be modulated to maintain a discharge air temperature setpoint (55-60) when mechanical cooling is available.
 - The reheat coils will add reheat to the system to maintain room temperature. Fan shall shutdown if the following occur:
 - High static pressure in the supply fan discharge.
 - Low static pressure on the suction side of the return fan.
 - Smoke is detected by smoke detectors in the supply fan discharge and/or the return air.
4. Each limit shall be a manual reset device. Smoke detectors (furnished and installed by the electrical contractor) shall be tied to the building fire alarm system to report a smoke condition that may exist. All limit alarms shall report to the facilities automation system.

Project Points

Bo = Binary Out ---- Supply Air Fan Start/Stop
Bi = Binary In ----- Supply Air Fan Status
Bi = Binary In -----Supply Air Fan High Static Alarm
Ao=Analog Out-----Supply Air Fan Speed
Bo = Binary Out ---- Return Air Fan Start/Stop
Bi = Binary In -----Return Air Fan Status
Bi = Binary In -----Return Air Fan Low Static Alarm
Ao=Analog Out-----Return Air Fan Speed
Ao = Analog Out ----Outdoor Air, Return Air & Exhaust Air Damper Control
Ai = Analog In -----Mixed Air Temperature
Bi = Binary In -----Pre-Filter Status (Runtime)
Ao=Analog Out-----Chilled Water Valve
Ao=Analog Out-----Hot Water Valve
Ao=Analog Out-----Face & Bypass Damper
Ai = Analog In -----Discharge Air Temperature
Bi = Binary In -----Final-Filter Status (run time)
Ai = Analog In -----Temperature Discharge Air Sensors
Ai = Analog In -----Duct Static Sensors (2 required – mount 2/3 downstream)
Bi = Binary In -----Supply Air Smoke Detector Alarm
Bi = Binary In -----Return Air Smoke Detector Alarm
Ai = Analog In -----Temperature Return Air Sensor
Ai = Analog In-----Return CO2 Sensor
Ai = Analog in-----Outdoor Air flow Station (By Equipment Manufacturer)

G. Heat Recovery Unit

1 Heat Recovery Unit shall consist of an outdoor and exhaust air damper, supply fan, return fan, heat wheel, chilled water coil and hot water coil with face & bypass damper.

2 The fan system/heat recovery shall have two modes of operation: Occupied or Unoccupied

OCCUPIED

3. The fan /system heat recovery unit shall run continuously at 100% as programmed through the local digital controller via the facilities automation system and status shall be proved via a current sensing relay. With the occupied sequence initiated, the following shall occur.
4. The associated exhaust fan shall be start and status shall be proved via a current sensing relay.
5. The outdoor air damper shall be positioned open 100% and monitored via end switch to prove status.
6. The exhaust fan bypass dampers shall be closed.

7. The isolation damper shall be positioned open 100%
8. Hot water valve shall be modulated as follows. When the outdoor air temperature is above 40 degrees the hot valve shall be modulated to maintain a discharge air temperature. When the outdoor air is below 40 degrees the hot water valve shall be positioned open 100% and the face & bypass shall modulate to maintain a discharge air temperature.
9. When chilled water is available the chilled water valve shall be modulated to maintain a 55 degrees discharge air temperature.
10. If at any point the return humidity exceeds 55% (Adj) the unit shall go into a dehumidification mode until the return humidity is satisfied.
11. Fan shutdown shall occur if:

Smoke is detected by smoke detectors in the fan discharge or exhaust air. Each limit shall be a manual reset device. Smoke detector shall be tied to the fire alarm system to report a smoke condition.

UN-OCCUPIED MODE

12. The fan /system heat recovery unit shall be off.

PROJECT POINTS

Bi==Binary In-----Supply Fan Status
Bi==Binary In-----Exhaust Fan Status
Bi==Binary In-----Outdoor Air Damper
Bi==Binary In-----Supply Smoke Detector
Bi==Binary In-----Exhaust Smoke Detector
Bo==Binary Out---Supply Fan Start/Stop
Bo==Binary Out---Exhaust Fan Start/Stop
Bo==Binary Out---Exhaust Bypass Dampers (2-each)
Bo==Binary Out---Dehumidification Mode
Ai==Analog In-----Discharge Air Temperature
Ai==Analog In-----Return Air Temperature
Ai==Analog In-----Return Air Humidity
Ao==Analog Out----Isolation Damper
Ao==Analog Out----Chilled Water Valve
Ao==Analog Out----Hot Water Valve
Ao==Analog Out----Face & Bypass Damper

H. FAN COIL UNITS

Fan coil units shall be controlled by an electronic DDC thermostat. This DDC thermostat shall be networked to the Metasys building automation system.

During the "**occupied**" mode, the unit fan shall run continuously with the unit coil valve modulated by the DDC thermostat to maintain room setting.

During the "**un-occupied**" mode, the unit fan shall run cycle by the DDC thermostat to maintain a reduced room temperature setting. At this time the unit coil valve shall be fully open.

Project Points

Ai == Analog In -----Room Temperature Ao == Analog Out ---Hot Water Valve Ao == Analog Out ---Chilled Water Valve Bo == Binary Out-----Fan Coil Fan Start/Stop Bi == Binary In-----Fan Coil Fan Status

I. Radiant Panels

- 1 An electronic DDC thermostat shall modulate a two-way control valve to maintain space temperature. This DDC thermostat shall be networked to the Metasys building automation system.

- 2 During the "Unoccupied" cycle the DDC thermostat shall maintain an unoccupied space temperature.
- 3 Where radiant panels are sequenced with other devices (i.e. duct mounted reheat coils), the radiation control valve shall be sequenced to be the first control valve to open on a call for heat and the last to close on a call for ventilation / cooling is required.

J. Cabinet Unit Heaters

- 1 An electric thermostat shall open the two way hot water valve and cycle the fan to maintain space temperature. A strap-on aqua stat shall be provided to prevent the operation of the unit fan unless hot water is available. All control devices shall be furnished and installed by the automatic temperature control manufacturer. All 120 Volt control interlock wiring shall be provided by this contractor.
- 2 Power wiring shall be by the electrical contractor.

K. Horizontal Unit Heater

- 1 An electric thermostat shall be installed to cycle the unit heater on a fall in space temperature. A strap-on aqua stat shall be provided to prevent the operation of the unit fan unless hot water is available. All control devices will be furnished and installed by the Automatic Temperature Control Contractor. All 120 Volt control interlock wiring shall be by this contractor.
- 2 Power wiring shall be furnished and installed by the electrical contractor.

L. Stand Alone Split Systems

- 1 Equipment manufacturer shall provide remote thermostat for ATC to install.
- 2 ATC to provide low voltage interlock to remote condensing unit.

M. General Exhaust Fan Operation - Monitoring

1. General exhaust fans shall be start-stopped and monitored for system operation and/or alarm. Refer to drawings for fans requiring operation/monitoring.

GENERAL EXHAUST FAN MONITORING:

Bo == Binary Out ---- Exhaust Fan Start/Stop

Bi == Binary In ----- Exhaust Air Fan Alarm/fault

N. Chilled Water Liebert Units

- 1 Equipment manufacturer shall provide remote thermostat for ATC to install.
- 2 ATC to provide low voltage interlock to remote condensing unit.
- 3 ATC contractor to furnish and install temperature sensor for monitoring purposes.

O. Carbon Dioxide Monitoring

1. ATC contractor to furnish and install CO2 sensors as shown on the drawings and tie into the BAS system for monitoring purposes only.

P. DIRECT DIGITAL VAV BOX

1. General: 120 VAC power shall be supplied to a junction box by the project electrical contractor. It will be the ATC Contractor's responsibility to provide any and all power conversion and distribution required to properly power the VAV box control system. A maximum of three VAV boxes shall be served by each power conversion/distribution device.
2. The ATC Contractor shall furnish to the box manufacturer (for factory installation by the box manufacturer) a DDC controller for each variable/constant volume box. DDC controller shall include an integral damper operator/differential pressure sensor. The box manufacturer shall install the DDC controller. The box manufacturer shall also connect the DDC controller to the airflow ring/cross furnished as part of the VAV/CV box. Box manufacturer shall include the cost for all factory mounting and connecting work in the variable volume box pricing given to the heating contractor
3. Warm-up Mode: The DDC network shall initiate the warm-up mode for the DDC VAV boxes. In the warm-up mode with the space temperature below the morning warm-up setpoint, the controller shall provide maximum CFM in conjunction with the area auxiliary heating systems(s) to area served. As warm-up setpoint is approached, the controller shall modulate the CFM to its minimum setting and area auxiliary heating coil(s) closed. In areas with radiant panels in conjunction with reheat coils, the reheat coils shall be the first to close with the radiant panels closing after the reheat coil. The warm-up mode shall be terminated locally at the controller when warm-up setpoint is reached, or remotely from the DDC network at zone occupied time.
4. Occupied Mode: Controller shall modulate damper actuator and auxiliary heating valve(s) to maintain local space temperature setpoint within the minimum and maximum air flows as configured within the controller or as provided via the DDC network. Note, when no hot water is available from the heating system (determined by a combination of hot water supply temperature and hot water pump run status), the boxes shall operate with "zero" as a minimum air flow.
5. Unoccupied mode: The damper actuator shall be positioned to the fully opened position at the end of the occupied mode via the DDC network. The auxiliary heating valve(s) shall be controlled to maintain reduced unoccupied space temperatures.
6. A discharge air temperature sensor shall limit the supply air temperature to the room by overriding the control of the reheat coil.
7. During the zone occupied cycle, as determined by the zone optimum start/stop schedule, loss of occupancy status as determined by the occupancy sensor shall cause the DDC controller to implement the standby setpoint strategy and SA reduction (typically a setpoint somewhere between typical occupied and unoccupied values) for the particular space involved
8. The room sensor shall have an integral plug for connection by the balancing contractor for setting the required airflow rates (as defined by the contract documents) for each box. Once the balancing contractor has set the flows, the information may be uploaded to the central system from the balancing contractor's laptop to define final system operating parameters.
9. Constant Volume – Reheat Boxes shall be controlled identical to the variable volume box except that the volume damper will be set by the balancing contractor to deliver a fixed volume of air at all

times except when no hot water is present, then the boxes shall go to 10% (adj.) of their scheduled cfm for the minimum flow.

(Typical for each box)

- AI - Space Temperature ~
- AI - Space Temperature Setpoint
- AO - Damper Control
- AO - Reheat Coil Control
- AO - Auxiliary Heating Control (Where Applicable)
- AI - Box Flow (CFM)
- AI - Discharge Air Temperature
- DI - Warm-up Mode
- DI - Unoccupied Override
- DI - Occupancy Sensor input (where applicable)

Q. HORIZONTAL UNIT HEATERS

1. A pendant mounted single temperature electric thermostat shall control the unit heater. A strap-on aquastat shall prevent fan operation if hot water is not available. On a fall in space temperature below the heating setpoint, the unit fan shall be cycled to maintain space temperature. The reverse sequence shall occur on a rise in space temperature.
2. All control devices will be furnished and installed by the ATC Contractor.
3. All interlock wiring shall be by the ATC Contractor.

R. BOILER COMBUSTION AIR CONTROL

1. An electric motor actuator shall be provided and interlocked with the burner controls of the heating system boilers and the domestic hot water system boiler to provide combustion air. The dampers shall position fully open when any burner is energized, and shall position closed when all burners are de-energized. An end switch interlock shall be used to verify full open damper position.

S. MER VENTILATION AIR CONTROL

1. On a rise in space temperature, a reverse acting thermostat shall open the electric motor operated air intake damper and start the power roof ventilator. The reverse sequence shall occur on a fall in space temperature.

T. EMERGENCY GENERATOR EXHAUST

1. When the Emergency Generator is energized, the generator recirculator dampers remain in the open position until the room temperature rises to 80°F (adj.). When the space temperature rises above 80°F (adj.) a reverse acting electric room thermostat shall open the outdoor air and exhaust air dampers and close the generator recirculator dampers. Damper actuators shall be electric.

U. SPLIT SYSTEM AND VARIABLE CAPACITY PACKAGED COOLING UNITS

1. Split system cooling only units shall be supplied with a factory furnished and installed control package. The ATC Contractor shall be responsible for mounting and wiring of the room sensor and Controller furnished by the unit manufacturer and interlock wiring between the indoor unit and the outdoor unit and the Indoor Unit and Radiant Panel(s). Start-up and check-out shall be by the unit manufacturer.

2. The variable capacity air conditioning system manufacturer shall provide a open protocol communication interface to connect the M-NET control system to the building automation system (BAS) for purposes of sending parameter and status information to and receiving typical operational commands from the BAS. Communication interface shall be furnished complete with all hardware, software, installation, start-up and commissioning required to establish a communication network with the BAS. Te variable capacity air conditioning system manufacturer shall coordinate with the ATC Contractor to determine interface communication media requirements (LONworks, BACnet, MS/TP, BACnet Ethernet or BACnet IP) and carry all associated costs in the variable capacity air conditioning system pricing given to the heating contractor. Variable capacity air conditioning system manufacturer shall be responsible for supplying the interface format as required by the ATC Contractor without additional costs to the ATC Contractor. ATC Contractor shall be responsible for gathering and displaying variable capacity air conditioning system status and performance information as part of the BAS colorgraphic package and incorporating critical performance data into the BAS alarming and trending packages developed for this project.

V. SELF CONTAINED PACKAGED COOLING UNITS

1. Self-contained cooling only units shall be supplied with a factory furnished and installed control package. The ATC Contractor shall be responsible for mounting and wiring of the room sensor furnished by the unit manufacturer. ATC Contractor shall also provide low voltage interlock to/from indoor unit and remote condensing unit. Start-up and check-out shall be by the unit manufacturer.

W. GRAVITY ROOF VENTS

1. Area gravity roof vents shall have a motorized operated damper where required . The damper shall open when the area/zone is in the "occupied" mode and close during the "unoccupied" mode.
2. Area gravity roof vents shall come furnished with vertical backdraft dampers. No associated work by ATC Contractor.

X. SWITCHGEAR INTERFACE

1. The switchgear supplier shall provide an RS-232 interface to allow the ATC contractor to interface with for load shedding control. The sequences for load shedding will be determined by the owner prior to start-up. This contractor shall furnish and install the cable with switchgear contractor providing the termination. This subcontractor shall coordinate load shed loads, priorities and setpoints with Owner

Y. ALARM REQUIREMENTS

1. The following alarm conditions, as further detailed by the owner, shall also be detected and an appropriate alarm generated. The ATC contractor, working in conjunction with owner, shall implement automatic email of selected alarms to the designated owner personnel. Additional method of alarm annunciation shall be coordinated with the owner.
 - Device failed to start/stop
 - Boiler alarm
 - Boiler E-Stop alarm
 - VFD alarm
 - High/low hot water supply temperature
 - High/low hot water system differential pressure
 - High/low chilled water supply temperature
 - High/low chilled water system differential pressure
 - Dirty filter

- Smoke detector alarm
- High/low mixed air temperature
- High/low supply air temperature
- High/low space temperature
- High CO₂ level
- High cooler/freezer temperature

Z. Trend Requirements

1. The following trends shall be implemented and automatically archived to the server as part of this project to aid in operating the building for maximum energy efficiency. Point selection shall be consistent with available memory and coordinated with the owner prior to implementation. The ATC contractor, working in conjunction with owner, shall implement automatic email of selected trends to the designated owner personnel.

- Hot water system – number of points and/or trends as determined by the owner
- Chilled water system - number of points and/or trends as determined by the owner
- Air handling units – trending done for each individual unit, number of points and/or trends as determined by the owner
- Variable volume boxes – representative boxes selected by the owner, number of points and/or trends as determined by the owner
- Unit Ventilators – representative unit ventilators selected by owner, number of points and/or trends as determined by the owner
- Fan coil units – representative fan coil units selected by owner, number of points and/or trends as determined by the owner
- Heat pump units – representative heat pump units selected by owner, number of points and/or trends as determined by the owner

END OF SECTION 230993

SECTION 235300 – CYCLE MINIMIZER

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

PART 2 – PRODUCTS

2.1 CYCLE MINIMIZER

- A. Provide temperature sensors, pressure transducers, and a N.E.M.A. 1 enclosure for wall mounting, with DDC controller of boilers, for modulating and on/off burner control of boilers, for reset of boiler water temperature in accordance with outdoor air temperature, for monitoring and alarming high boiler water pressure and for on/off control of boiler circulating or blend pumps. Some components, functions, and capabilities shall include the following:

1. Temperature sensors with following function and location:
 - a. Hot water supply to load; to be within 24" of air separator outlet.
 - b. Outlet temperature at boiler, to be within 12" of boiler connection.
 - c. Common boiler H.W.S. loop temperature; to be 36" after last boiler circulating pump discharge connection.
 - d. Common hot water return from load temperature; to be within 36" of common H.W.R. connections.
 - e. Outside air temperature; to be on North side of building or in representative area where sun does not shine. Use of sun shield is not acceptable. This sensor shall be provided by the ATC Sub-Contractor. Both shall utilize for on/off/reset.
2. Wall mounted N.E.M.A 1 enclosure shall be hinged type. Face panel on enclosure shall have signal lights for heating system enabled, Boiler #1 and #2 call for heat, high boiler pressure and boiler circulating pump failure. Signal lights shall be low voltage and push-to-test type.
3. Extend burner firing periods to increase seasonal efficiency by reducing burner on/off cycles at Boiler #1. Control to adjust boiler response to load changes by analyzing return water temperature, outside air temperature, boiler water temperatures and blend temperature to load. Controller shall also determine when lag boiler should be energized.
4. Receive dry contact switching from building DDC system for:
 - a. Heating system on/off.
 - b. Occupied reset schedule required.
 - c. Unoccupied reset schedule required.
 - d. Reheat reset schedule required.
5. Provide dry contact switching to building DDC system for:
 - a. Boiler #1 enabled.
 - b. Boiler #1 down on failure condition.
6. Generate a 0 to 10 volt D.C. or 4-20 ma signal for 3-way electric diverting valve provided by BAS Installer. Provide 120/60 motor power.

7. Generate a line voltage on/off switched signal and a 135 ohm modulating signal for Boiler #1.
8. Rather than maintain a single temperature throughout the heating season, the boiler loop water temperature shall vary as follows:

Boiler Water Temperature	Outside Air Temperature
200° F	0° F and below
190° F	7.5° F
180° F	15° F
170° F	22.5° F
160° F	30° F and above

9. Temperature to load to vary as follows:

Occupied Temperature	Blended	Unoccupied Temperature	Blended	Outside Temperature	Air
200° F		185° F		0° F	
175° F		160° F		15° F	
150° F		135° F		30° F	
135° F		120° F		45° F	
120° F		100° F		60° F	

10. Provide on/off control for boiler circulating pumps by the use of combo current switch/command relays at the pump starters. Prove pump operation before energizing boiler. Main systems circulating pumps shall be controlled by the A.T.C. subcontractor, but monitored by the Cycle Minimizer.
11. Boiler #1 shall be brought online with a ramped firing to minimize thermal stresses. Burner shall be in low fire position for five (5) minutes, 50% input for five (5) minutes and 75% for five (5) minutes before burner is allowed of continue to high fire and then modulate in accord with the load.
12. Pressure transducers shall monitor system water pressure to avoid relief valve weeping or opening caused by failure of pressure regulating valve on cold water supply line or caused by incorrect pressurization of diaphragm tank. A transducer shall be installed in a tapping at each boiler. A common flashing manual reset alarm light shall be provided. Actual pressure reading at boiler to be available at keyboard display for monitoring purposes.
13. Accept interlock with emergency generator system. Contact shall be N.O. when on normal power; N.C. when on emergency power. Controller shall limit firing to a single boiler regardless of the heating system demands when system is on emergency power.
14. Keyboard Display:
 - a. With 4 level password protection.
 - b. To view status and values.
 - c. To view and acknowledge alarms.
 - d. To place points in test or manual override mode.
 - e. To change setpoints and set alarm limits.
 - f. User friendly and using self prompting menus.
 - g. View all points.
 - h. Customized system pages.

15. When selected, the keyboard display shall provide the following:

- a. Outside air temperature.
 - b. Boiler #1 outlet temperature.
 - c. Common H.W.S. boiler loop temperature.
 - d. Temperature to load.
 - e. Common H.W.R. temperature from load.
 - f. Pressure at boiler.
 - g. Boiler status.
 - h. Cumulative run time of boiler.
 - i. Percent opening at modulating gas valve at Boiler #1 and Boiler #2.
 - j. Boiler circulating or blend pump status.
16. The Cycle Minimizer shall communicate with the Building Automation System through a native BACnet protocol. Both shall read off the same outdoor air temperature sensor provided by the BMS Sub-Contractor.
 17. This controller shall be a standard product of the manufacturer that was specifically designed for boiler and 3-way mixing/diverting valve control. Manufacturer's submittal material shall include catalog material and a list of ten (10) percent projects with simultaneous control of boilers and 3-way valve. For each project, the list shall include name and address of installation, name of local contact and phone number, date of installation, quantity of boilers, and firing mode, i.e., ON-OFF, LO-HI-LO-OFF, or modulating.
 18. Controller shall include an integral modem. Owner shall provide phone line for interfacing with vendor's remote communication site. Following the startup, the vendor shall use the communication link to monitor the system throughout the warranty period. Adjustments shall be made from vendor's site as required to enhance heating system performance.
 19. Provide CAD generated drawings including a single drawing with factory and field wiring at Cycle Minimizer and burner and boiler units plus field wiring between systems. Multiple wiring diagrams are not acceptable.
 20. Vendor shall provide startup and adjustments and instruction for owner's personnel. This controller shall be fully operational when the boilers are initially put online.
 21. All aspects of the Cycle Minimizer (i.e., engineering, programming, panel assembly, commissioning and warranty) must be provided by the boiler vendor and may not be subcontracted out.
 22. Controller shall be Cycle Minimizer as manufactured by the James S. Gunst Co.
- B. No efforts to control the cycling of the boilers by A.T.C. personnel, in place of the boiler manufacturer's CYCLE MINIMIZER, shall be accepted by Engineer.

PART 3 - EXECUTION

3.1 NOT APPLICABLE

END OF SECTION 235300

SECTION 260536 - CABLE TRAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes aluminum cable trays and accessories.

1.3 SUBMITTALS

- A. Product Data: Include data indicating dimensions and finishes for each type of cable tray indicated.
- B. Shop Drawings: Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Cope, T. J., Inc.; a subsidiary of Allied Tube & Conduit.
 2. GS Metals Corp.; GLOBETRAY Products.
 3. MONO-SYSTEMS, Inc.

2.2 MATERIALS AND FINISHES

- A. Cable Trays, Fittings, and Accessories: Aluminum, complying with NEMA VE 1, Aluminum Association's Alloy 6063-T6 for rails, rungs, and cable trays, and Alloy 5052-H32 or Alloy 6061-T6 for fabricated parts; with splice-plate fasteners, bolts, and screws.
- B. Sizes and Configurations: Reference shall be made to the Cable Tray shown on Drawings for configurations.
 - 1. Cable tray shall be center-hanger supported.

2.3 CABLE TRAY ACCESSORIES

- A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.
- B. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.4 WARNING SIGNS

- A. Lettering: 1-1/2-inch- high, black letters on yellow background with legend "WARNING! NOT TO BE USED AS WALKWAY, LADDER, OR SUPPORT FOR LADDERS OR PERSONNEL."
- B. Materials and fastening are specified in other sections of the specifications.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with recommendations in NEMA VE 2. Install as a complete system, including all necessary fasteners, hold-down clips, splice-plate support systems, hinged horizontal and vertical splice plates, elbows, reducers, tees, and crosses.
- B. Remove burrs and sharp edges from cable trays.
- C. Fasten cable tray supports to building structure.
 - 1. Place supports so that spans do not exceed maximum spans recommended by manufacturer.
 - 2. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.
 - 3. Support bus assembly to prevent twisting from eccentric loading.
 - 4. Manufacture center-hung support, designed for 60 percent versus 40 percent eccentric loading condition, with a safety factor of 3.
 - 5. Locate and install supports according to NEMA VE 1.
- D. Make connections to equipment with flanged fittings fastened to cable tray and to equipment. Support cable tray independent of fittings. Do not carry weight of cable tray on equipment enclosure.

- E. Install expansion connectors where cable tray crosses building expansion joint and in cable tray runs that exceed dimensions recommended in NEMA VE 1. Space connectors and set gaps according to applicable standard.
- F. Make changes in direction and elevation using standard fittings.
- G. Make cable tray connections using standard fittings.
- H. Seal penetrations through fire and smoke barriers according to Division 07 Section "Penetration Firestopping."
- I. Workspace: Install cable trays with enough space to permit access for installing cables.
- J. After installation of cable trays is completed, install warning signs in visible locations on or near cable trays.
- K. Ground cable trays according to manufacturer's written instructions.

END OF SECTION 260536

SECTION 260943 - NETWORK LIGHTING CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Network integrated power switching systems.

B. Related Information:

1. Division 26 Section "Electrical General Provisions".
2. Division 26 Section "Wiring Devices".

1.2 REFERENCES

A. National Fire Protection Association (NFPA):

1. NFPA 70 - National Electrical Code.

B. Underwriters Laboratories (UL)

1. UL 508 – Industrial Control Equipment

1.3 SYSTEM DESCRIPTION

- A. Web Accessible, network connected, lighting control system utilizing preset control software, central signal microprocessor, lighting control panel including integrated branch circuit protection, and solid-state power switching modules and relays.

B. System Components: System includes the following addressable components:

1. Keypad controls.
2. Touch panel controls.
3. Remote occupancy sensors.
4. Room-combining partition sensor.
5. Daylight compensating lighting controls.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product required for complete network lighting control system, demonstrating compliance with requirements.

B. Shop Drawings: Indicate the following:

1. Schematic diagram showing complete network lighting control system and accessories.
2. Circuits and emergency circuits with capacity and phase, control zones, load type and voltage per circuit.

1.5 INFORMATIONAL SUBMITTALS

- A. Sample of manufacturer's warranty.
- B. Load Measurement Report: Submit field test report of completed installation.

1.6 CLOSEOUT SUBMITTALS

- A. Operating and maintenance instructions.

1.7 QUALITY ASSURANCE

- A. **Manufacturer Qualification:** Manufacturer of network lighting controls with minimum [five] years record of satisfactory manufacturing and support of components comparable to basis of design system.
- B. **Source Requirements:** Provide Network Lighting Controls through a single source from a single manufacturer.
- C. **Electrical Components, Devices, and Accessories:** UL listed and labeled per NFPA 70.

1.8 COORDINATION

- A. Coordinate integrated lighting and dimming controls with systems and components specified in the following sections:
 - 1. Division 26 Section "Panelboards".
 - 2. Division 26 Section "Wiring Devices".

1.9 PROJECT CONDITIONS

- A. **Environmental Conditions Range:**
 - 1. Temperature: 32 – 104 deg F.
 - 2. Relative Humidity: 10 – 90 percent, non-condensing.

1.10 WARRANTY

- A. Warranty shall cover all equipment for one year after acceptance of the project.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Equipment specified is as manufactured by Creston. Equipment as manufactured by Lutron can also be submitted as Base Bid.

2.2 SYSTEM CHARACTERISTICS

- A. Web-accessible, network-connected programmable lighting control system that receives digital or analog signals from addressable input devices, assembles signals at central signal processor, and distributes operating signals to addressable control devices that effect a change in state.
 - 1. Electronic power switching modules and relays process signals and effect circuit on-off switching, emergency switching, and 0 – 10V fluorescent dimming where indicated. Emergency switching overrides preset state and puts each circuit to the programmed emergency condition. Buttons on the module provide manual disconnect and manual circuit testing.

2.3 NETWORK LIGHTING CONTROL PANELS

- A. Control Panels, General: Comply with NEMA PB 1 and UL 50, UL 67, UL 489, and UL 916.
- B. Circuit Protected Network Lighting Control Panels: Arc-less high inrush.
 - 1. Crestron, Green Light Power Switching Network Lighting Control panel Model GLPS-HSW.
 - 2. Main Circuit: As indicated
 - 3. Branch Circuit Protection: 120/208 or 277/480 20 amp thermal magnetic type.
 - 4. Switching Relay Types: Arc-less high inrush, lifetime rated minimum 1,000,000 on/off cycles, with air gap off protection.
 - 5. Cabinet Capacity: As required for circuits indicated.
- C. Feed-Through Network Lighting Control Panels: Arc-less high inrush.
 - 1. Crestron Green Light Express Power Switching Network Lighting Control panel Model No. GLPS-HSW-FT.
 - 2. Branch Circuit Protection: Pass through type utilizing separate branch circuit protection indicated on Drawings.
 - 3. Switching Relay Types: Arcless high inrush, lifetime rated minimum 1,000,000 on/off cycles, with air gap off protection.
 - 4. Cabinet As required for circuits indicated.

2.4 POWER SWITCHING ACCESSORIES

- A. Switching Module, High Inrush:
 - 1. Crestron Electronic Power Switching Module Model No. GLXP-SW- series.
 - 2. Maximum Load.
 - a. Lighting: 16A per channel.
- B. Switching Module, 0 – 10V Dimmable Fluorescent Ballast Load Switching Module:

1. Crestron Electronic power switching module Model No. GLXP-GLXP-DIMFLV8.
 2. Channels of Switching: 8 channel high inrush switching.
 3. Maximum Non-dimmable Load:
 - a. Incandescent, HID, magnetic low voltage (MLV), electronic low voltage (ELV), neon/cold cathode, and fluorescent ballasts: 16A per channel.
 - b. Motor: 1/2HP at 120V or 1HP at 230/277V per channel.
 4. Maximum Dimmable Load:
 - a. Lighting: 0 - 10V dimmable fluorescent ballasts.
- C. Emergency Phase Loss Sensor: 120/277V, tripping transfer to emergency state.
1. Crestron Model No. GLS-PLS-120/277.
- D. Power Supply: 50W, 24 V regulated power supply with two 4-pin network connectors, fuse-protected.
1. Crestron Cresnet Power Supply Model GLA-PWS-50.

2.5 CENTRAL SIGNAL PROCESSOR

- A. Control Processor: Wall-mounted lighting control processor enabling user system programming via LCD front panel or PC software, integrating occupancy sensing, daylight harvesting, and remote management. 2 RS-232, 4 digital/analog input, & 4 relay control ports. 3-gang standard box configuration.
1. Crestron Integrated Professional Automation Computer Model IPAC-GL1.
 2. Face Color: Black.
- B. Control Processor: Network connected dual bus programmable control processor for low voltage controls, devices, and subsystems through multiple control interfaces. SNMP support, with built-in firewall, NAT, and router. 4-wire bus providing 24 VDC power to network devices, with two independent sensing inputs. In separate enclosure.
1. Crestron Professional Automation Control System Model PAC2.
 2. Mounting: Surface-mounted or Modular enclosure-mounted, in array indicated.
- C. Control Processor: Integrates sensors and other low voltage controls, devices, and subsystems through multiple control interfaces with control network. Enables addition of relays, 8 separate I/O ports in 2 isolated segments supporting up to 20 devices each, serial COM ports, DTMF interfaces, and shade controllers. MMC memory expansion card slot. 4-wire bus providing 24 VDC power to network devices, with two independent sensing inputs. Use with separate power supply.
1. Crestron Professional Automation Mini-Control System Model PAC2M.
 2. Mounting: Surface-mounted or Modular enclosure-mounted, in array indicated.

2.6 SYSTEM ACCESSORIES

- A. Touchpanel: Controls lighting and AV settings along with other modular dimming controller functions.
1. 5.7 inch active-matrix color LCD touch screen 640 by 480 SVGA resolution display.
 - a. Crestron Isys TPS-6L Touchpanel.
 2. 16-bit color graphics, and dual-window HD video, HDTV, and high-resolution RGB streaming multimedia, IP intercom, and web browsing capabilities. Dynamic graphics and text capability. Enables custom control screen programming.

3. Video display: Scalable display on touchpanel screen.
 4. Pushbutton Controls: 12 engraved backlit tactile pushbuttons for volume, channel, and on-screen menu navigation and programmable functions, snap-on front bezel button cover, and custom Engraveable button kit.
 5. Mounting Kit: Wall mounting kit with power, wired Ethernet and CAT5 video connectivity, with back box and trim ring.
 6. Powerpack: 24VDC.
 7. Color: Almond or Black or White.
- B. Touchpanel: Controls lighting and AV settings along with other modular dimming controller functions.
1. 3.6 inch active-matrix compact color LCD touch screen 320 by 240 QVGA resolution display.
 - a. Crestron Isys TPS-4L Touchpanel.
 2. 16-bit color graphics, and dual-window HD video, HDTV, and high-resolution RGB streaming multimedia, IP intercom, and web browsing capabilities. Dynamic graphics and text capability. Enables custom control screen programming.
 3. Video display: Scalable display on touchpanel screen.
 4. Pushbutton Controls: 10 engraved backlit tactile pushbuttons for volume, channel, and on-screen menu navigation and programmable functions, snap-on front bezel button cover, and custom engraveable button kit.
 5. Mounting Kit: Flush wall Lectern mounting kit with power, wired Ethernet and CAT5 video connectivity, with back box and trim ring, and speaker kit.
 6. Powerpack: 24VDC.
 7. Color: As selected from manufacturer's full range of minimum 10 colors.
- C. Remote Keypad Controls: Field-configurable remote keypad with auto-adjusting backlight illuminating replaceable, Engraveable programmable buttons in number indicated, with white LED indicators, configured to fit in standard single-gang box.
1. Crestron, Cameo Series Keypad Model C2N-CB (D/F) Series.
 2. Color: As selected from manufacturer's full range of minimum 12 colors.
- D. Remote Keypad Controls: Remote keypad with[backlight illuminating] replaceable, engravable buttons in number indicated, with amber LED indicators, configured to fit in standard single-gang box.
1. Crestron, Designer Series Keypad Model CNX- Series.
 2. Faceplates: As selected from manufacturer's full line.
- E. Remote Keypad Controls: Remote keypad with replaceable, Engraveable buttons in number indicated, with red LED indicators, 3W, configured to fit in standard single-gang box.
1. Crestron, Decorator Series Keypad Model C2N-DB Series.
- F. Remote Control: Handheld infrared remote control device.
- G. Infrared Remote Receiver: Provide integral 36 kHz infrared receiver for use with remote control.
- H. Passive Infrared Occupancy Sensors: Passive infrared detection with internal microprocessor. Sensor independently adjustable for installed conditions. Delayed time off adjustment. Walk-through mode. Adjustable built-in photocell for daylight optimization. Equipped with 3-wire interface for direct connection to control system; 24 VDC power from network control bus.
1. Crestron Photocell Model GLS-OIR Series.

2. Mounting and Coverage: Low profile ceiling surface mounted, 360 deg., 450 sq. ft., Low profile ceiling surface mounted, 360 deg., 1500 sq. ft., Wall bracket mounted, 360 deg., 2500 sq. ft. Ceiling bracket mounted, 360 deg., 2500 sq. ft. ,as indicated.
- I. Remote Occupancy Sensors: Combination of ultrasonic motion detection and passive infrared detection with internal microprocessor. Sensor independently adjustable for installed conditions. Delayed time off adjustment. Walk-through mode. Adjustable built-in photocell for daylight optimization. Equipped with 3-wire interface for direct connection to control system; 24 VDC power from network control bus.
 1. Crestron Photocell Model GLS-ODT Series.
 2. Coverage: 180 deg., 500 sq. ft., 360 deg., 1000 sq. ft., 360 deg., 2000 sq. ft., 1200 sq. ft.
 3. Mounting: Ceiling flush mounted, Ceiling surface mounted, Ceiling bracket mounted, Wall flush mounted, Wall surface mounted, Wall bracket mounted, as indicated.
- J. Occupancy Sensor Interface Device: Integrates occupancy sensors and related sensors with control network. In separate enclosure. 4-wire bus providing 24 VDC power to network devices, with two independent sensing inputs.
 1. Crestron Sensor Integration Module Model GLS-SIM.
- K. Photocell Sensor, Open Loop Type: Continually monitors daylight entering window or skylight to enable daylight harvesting applications to provide control of room lighting based on presence of daylight. Equipped with 3-wire interface for direct connection to control system utilizing control processor; 24 VDC power from network control bus.
 1. Crestron Photocell Model GLS-LOL.
 2. Mounting: Ceiling flush mounted, Ceiling surface mounted, Wall flush mounted, Wall surface mounted, as indicated.
- L. Photocell Sensor, Closed Loop Type: Continually monitors daylight at work station location to enable daylight harvesting applications to provide control of room lighting based on lighting level at workstation. Equipped with 3-wire interface for direct connection to control system utilizing control processor; 24 VDC power from network control bus.
 1. Crestron Photocell GLS-LCL.
 2. Mounting: Ceiling flush mounted, Ceiling surface mounted, Wall flush mounted, Wall surface mounted, as indicated.

2.7 CONDUCTORS AND CABLING

- A. Power Supply Side of Remote-Control Power Sources: Comply with requirements of Division 26.
- B. UTP Cable: 100-ohm, UTP. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
 1. Communications Control Cable, Plenum Rated: 22 AWG data pair, stranded bare copper and 18 AWG power pair, stranded bare copper, Type CMP, complying with NFPA 262.
 - a. Crestron CRESNET-P.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Prior to installation, examine work area to verify measurements, and that commencing installation complies with manufacturer's requirements.

3.2 INSTALLATION

- A. Do not install network power controls until space is enclosed, HVAC systems are running, and overhead and wet work in space are complete.
- B. Install network power switching controls in accordance with manufacturer's instructions.
- C. Grounding: Provide electrical grounding in accordance with NFPA 70.
- D. Provide panelboard schedule in pocket provided in panel doors.

3.3 SOFTWARE

- A. Install and program software to meet the Owner's requirements. Provide current licenses. And backup copies of the software for the Owner's records.

3.4 SYSTEM STARTUP

- A. Provide manufacturer's system startup and adjustment.
- B. Switch each load on and off with manual line test feature of the power switching module before installing processors.
- C. Perform operational testing to verify compliance with Specifications. Adjust as required.

3.5 ADJUSTING

- A. Within 12 months of the date of Substantial Completion provide onsite service to adjust the system to account for actual occupied conditions.

3.6 DEMONSTRATION

- A. Provide a factory authorized service representative to instruct owner's staff to adjust, operate and maintain network power switching systems; and provide instruction using the system software. Training on site shall be a minimum of four (4) hours.

3.7 CLOSEOUT ACTIVITIES

- A. Demonstration: Schedule demonstration with Owner.

- B. Training: Train Owner's personnel to operate, maintain, and program network power switching systems. Allow for a minimum of trips to the jobsite to provide additional training as needed.
 - 1. Furnish set of approved submittals, and record drawings of actual installation for Owner's personnel in attendance at training session.

END OF SECTION 260943

SECTION 263215 – GENERATOR UNDERGROUND FUEL TANK AND DAY TANK

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section of the specifications specifies the underground diesel fuel oil tank, fuel tank monitoring system, overfill alarm and the generator day tank with dual pumps and controls.
- B. This Contractor is responsible for the complete installation of the equipment herein specified. The piping for the fuel oil system shall be furnished and installed by the Mechanical Contractor as specified in other divisions of the project documents.

PART 2 - PRODUCTS

2.1 UNDERGROUND FUEL TANK

- A. General
 - 1. Furnish and install a 1,000 gallon sti-P3 external corrosion and cathodically protected steel underground storage tank.
- B. Labeling
 - 1. Tank shall bear the Steel Tank Institute sti-P3 identification label.
 - 2. Underground tank shall bear the appropriate Underwriters Laboratories (UL) label.
- C. Product Description
 - 1. Tank shall be manufactured in accordance with Steel Tank Institute sti-P3 Specification and Manual for External Corrosion Protection of Underground Steel Storage Tanks.
 - 2. Tank shall be manufactured in accordance with and listed for Underwriters Laboratories UL 58, Steel Underground Storage Tanks for Flammable and Combustible Liquids. UL-1746 External Corrosion Protection Systems for Steel Underground Storage Tanks or ULC-S603.1, Standard for Corrosion Protection for Steel Underground Tanks for Flammable and Combustible Liquids.
 - 3. Double-wall tank shall provide testable secondary containment and access for interstitial leak detection monitoring.
 - 4. Tank shall be provided with the ability to monitor the corrosion protection system.
- D. Manufacturer
 - 1. Manufacturer shall be a licensed member company of the Steel Tank Institute and subject to Steel Tank Institute's Quality Assurance program.
- E. Installation
 - 1. Install as noted on the plans.

2.2 FUEL TANK MONITORING SYSTEM

- A. These specifications describe a continuous underground monitoring and leak detection system that shall perform in accordance with Subpart D of 40 CFR 280 and, as a standard of performance and quality, shall meet the performance specifications and functions of the Veeder-Root Company TLS-300C UST Monitoring system.

The underground storage tank monitoring system shall meet all applicable standards and regulatory agency requirements including, but not limited to, the standards and requirements of the following:

1. American National Standards Institute (ANSI)
2. American Petroleum Institute (API)
3. American Society for Testing and Materials (ASTM)
4. Environmental Protection Agency (EPA)
5. National Bureau of Standards (NBS)
6. National Electrical Code (NEC)
7. National Fire Protection Agency (NFPA)
8. Underwriters Laboratories Inc. (UL)
9. Underground Storage Tanks: Subpart D, 40 CFR Part 280
10. Federal Communications Commission (FCC)
11. Factory Mutual (FM)

B. In-Tank Leak Detection

1. The system shall utilize in-tank probes based on the magnetostrictive principle for liquid level measurement and in-tank leak detection.
2. The tank gauge shall be capable of performing a static tank tightness test to an accuracy of 0.1 GPH with at least a 98% probability of detection [P(D)] and no more than 1% probability of false alarm [P(FA)].
3. The system shall have the ability to be programmed to run a static 0.2 GPH quick leak test. The static leak test will take one hour and commence 30 minutes after the last dispensing cycle, or five hours from the last delivery, whichever is greater.

C. Wet Monitoring

1. The system shall be able to perform automatic, continuous leak sensing by monitoring the liquid level in the reservoir of a brine-filled interstitial space (annulus) of a double wall tank, to detect a breach in the inner or outer shell.
2. The system shall differentiate between a high liquid level and a low liquid level in the brine reservoir of a double-wall tank and provide a high-liquid alarm or a low-liquid alarm.

D. Dry Monitoring

1. The system shall be able to perform automatic, continuous leak sensing in the dry interstitial space (annulus) of a double wall tank, to detect a breach in the inner or outer shell.
2. The system shall have the ability to sense the presence of hydrocarbons and/or liquid, and provide an alarm for the worst case condition (fuel).
3. The form factor of the sensor must provide for easy field installation and removal.

4. The system shall have the ability to continuously monitor the integrity of the sensor for an open condition, alarm condition, or normal operating condition.
- E. Containment Sump Monitoring
1. The system shall be able to perform automatic, continuous leak sensing in the piping containment sump.
 2. The system shall have the ability to detect the presence of liquid (hydrocarbons and/or water) in the piping containment area and provide an alarm condition.
 3. The system shall have the ability to indicate when the sensing device has failed and is no longer providing environmental compliance.
 4. The system shall have the ability to continuously monitor the integrity of the sensor for an open condition, alarm condition, or normal operating condition.
- F. Environmental Compliance Reports
1. The system shall have the ability to provide a record of the last three occurrences of each type of alarm or warning condition detected by the system.
- G. Product Inventory control (Tank Gauging)
1. The tank management system shall collect product height and temperature data from up to two magnetostrictive level probes and compute gross and temperature-compensated net gallons.
 2. The system shall automatically generate an inventory increase report when a delivery of product to a tank has taken place. The report shall include the time and date of the delivery, the starting volume in the tank, the ending volume in the tank, the starting temperature of the fuel, the ending temperature of the fuel, and the inventory increase amount.
- H. Inventory Management Reports
1. The system shall monitor inventory in U.S. or Metric units and produce a combination of automatic and manual reports for each tank, as specified in other sections of this specification.
 2. The system shall be able to generate reports in a display/printer format as well as a computer format upon demand.
- I. Communications
1. The tank monitoring system shall provide the ability to communicate with locally attached electronic devices through an RS-232 port, or remote locations via an RS-232 port. The system shall provide data in a display or packed computer data format.
- J. Output Relay
1. The system shall provide the ability to enable external audible/visual alarms, or control external devices through a relay contact closure.
 2. The system shall provide 2 Form C contact relays.
- K. Input Interface
1. The system shall provide the ability to accept an input from an external device and enable a relay to control an external device.

L. Alarms

1. The tank monitoring system shall provide an audible and visual indication of all system in-tank leak, product line leak, and external sensor alarm conditions.
2. The system alarm conditions shall include:
 - a. Maximum Product level
 - b. High level limit
 - c. Overfill alarm
 - d. High water alarm
 - e. Second high water alarm
 - f. Delivery needed alarm
 - g. Low limit
 - h. Sudden Loss
3. The system shall be equipped with an external audible and visual alarm with acknowledgement switch. The external alarm box and acknowledgement switch shall be contained in a watertight gasketed enclosure for installation in an outdoor environment. The external alarm box and acknowledgement switch shall interface to the tank monitoring system via an internal relay.

M. Setup (Startup/Installation)

1. The system shall contain parameter-driven software to adapt the tank monitor to site specifications. The parameters must be enterable in assigned fields at the time of system startup. In addition, the parameters must be field updatable so that changes in tank dimensions and site specifications can be made.

N. Diagnostics/Troubleshooting

1. All diagnostic information shall be generated by the system itself. The system shall not allow the user to change or enter diagnostic information in any way.

O. Console

1. The console shall be wall mounted using external mounting tabs.
2. The console shall be equipped with a 2-line, 24-character liquid crystal display for on-site viewing of all inventory, leak detection, and alarm information.
3. The console shall provide 2 form C contact relays to provide the ability to enable an external audible/visual alarm or control external devices.
4. The console shall be equipped with three 1-3/4" conduit knockouts on the top and the bottom of the monitor for rigid conduit entry into the monitor. One conduit entry shall be designated for the intrinsically safe compartment, and two conduit entries (top and bottom) shall be designated for the high-power compartment.
5. The console shall be separated into two compartments for: 1) intrinsically safe wiring and devices; 2) high-power wiring and devices.
6. The console shall have an internal quick-disconnect connector for 120 VAC wiring to the console for ease of installation, service, and troubleshooting.

P. Probes

1. The probe shall be capable of utilizing standard non-shielded gas- and oil-resistant wire between 14 AWG and 18 AWG for field connections.
2. There shall be no more than two conductors between each probe and the control console.

3. The probe shall be capable of performing a leak detect test to 0.1 GPM or higher.
4. Third-Party Certification is required in accordance with the U.S. EPA's "Standard Test Procedure for Evaluating Leak Detection Methods: Automatic Tank Gauging Systems" (0.2 GPH monthly monitoring).
5. Third-Party Certification is required in accordance with the U.S. EPA's "Standard Test Procedure for Evaluating Leak Detection Methods: Volumetric Tank Tightness Testing Method" (0.1 GPH annual tank tightness test).
6. The probe shall be compatible for aboveground tank installations as well as underground tank installations.
7. A cap and ring kit, available from the manufacturer, shall be supplied with each probe for easy installation and removal.
8. The probe shall use a digital communications protocol format for maximum RF/EMF immunity.

Q. Sensors

1. The system shall provide the ability to monitor up to 8 interstitial areas and/or containment areas, utilizing a standard float style sensor.

R. Piping Sump Sensor

1. The piping sump sensor shall be of PVC construction, utilizing a float and reed switch technology to sense the presence of liquid. The sensor shall also be supplied with a mounting bracket for installation of the sensor in a containment area.
2. The piping sump sensor shall be 12" long to address monitoring in piping containment sumps, as well as dispenser pan/sump areas.
3. The sump sensor shall be designed with a five-foot leader cable to connect the sensor to field wiring in the sensor junction box. The sensor shall be supplied with watertight cord grip assemblies to install in the sensor junction box.

S. Hydrostatic Sensor

1. The hydrostatic sensor shall be supplied by the manufacturer in a dual-float configuration.
2. The dual-float hydrostatic sensor shall be 19" long with a clear Lexan tubular housing for visible confirmation of sensor operation. The sensor shall be 2.5" in diameter to install in the riser pipe assembly of a double-wall tank brine reservoir.

T. Interstitial Sensor for Double-Wall Steel tank

1. The interstitial sensor for a double-wall steel tank shall be 2.5" high and 1.5" in diameter to fit into a riser pipe for a double-wall steel tank of 1.5" I. D. or greater.
2. The steel tank interstitial sensor shall be equipped with a 25-foot leader cable to connect the sensor to field wiring in the sensor junction box.

U. Communications

1. The system shall have the capability of communicating directly with a computer, teletype, or printer.

V. Field Service

1. The manufacturer shall maintain a nation-wide field service staff to provide on-site customer support and training, as well as over seeing installation of tank monitoring system by installation contractor.
2. The distributor/contractor field service representative shall be available for on-site training of company maintenance personnel on installation, programming and troubleshooting of tank monitoring system. Provide 4 hours of on site training for Owner's personnel.

W. Warranty Registration and Checkout Form (WRACO)

1. The manufacturer shall require that all UST/AST monitoring systems be started up by an authorized distributor.
2. The startup shall consist of installation checkout, operation checkout, and customer training on use of the equipment.
3. The manufacturer shall supply a Warranty Registration and Checkout Form to properly document the site information to include:
 - a. Installation location
 - b. Installer
 - c. Equipment identification
 - d. Tank information
 - e. Leak detector information
 - f. Start up distributor information
 - g. Customer approval

X. System Warranty

1. The tank monitoring system shall be warranted for a period of one year from date of installation or 15 months from date of invoice.
2. The warranty is to include parts and labor, with all warranty work performed on site by an authorized manufacturers' representative.

Y. Veeder-Root Monitoring System Equipment

1. Following is a listing of the Veeder-Root equipment to be furnished:

Veeder-Root 848590-521	TLS300C Console with Printer; Standard RS-232 Feature. No Built-in SiteFax Modem.
Veeder-Root 330161-001	Static In-Tank Testing SEM (Software Enhancement Module) For TLS300C or TLS300I.
Veeder-Root 846390-101	.1 GPH Magnetostrictive Plus Tank Inventory Probe – 48”.
Veeder-Root 846400-001	Magnetostrictive Plus Tank Inventory Probe Installation Kit with 4” Product Float, Water Float, 5’ Cable-Diesel.
Morrison 305XPA- 1200AK	4” Cap and Ring Probe Mounting Kit with ½” cable connector

OPW 104A-1200 12"	12" Round Manhole with Lid
Veeder-Root 790091-001	Remote Audible Overfill Alarm
Veeder-Root 790095-001	Remote Overfill Acknowledgement Switch

2.3 FUEL OIL DAY TANK

A. General

1. Provide a packaged design fuel oil day tank for the prime mover. Day tank shall be complete in all respects to provide the prime mover with a reliable, local source of fuel. Day tank shall be for use with main tank and fuel delivery system to provide an automatic, self-refilling fuel supply system.
2. The day tank shall be designed and supplied as an engineered system by the manufacturer. Tank shall be of packaged design with digital monitor and shall include all inlet flow control devices, other valves, level controls, pump control, indicators, alarms and all other devices as required to form an integrated, functional system such that field installation is restricted largely to external piping, wiring and intermediate devices that are required by code to interconnect the bulk source of supply to the day tank, the day tank to the prime mover and to provide for external vents as per local codes and UL142, NFPA31 and NFPA37.
3. The system shall be for use with fuel oil as described by NFPA321, "Basic Classification of Flammable and Combustible Liquids". As defined by this standard, the fuel supply system shall be for use with "combustible liquids", those having a flash point at or above 100°F and further defined as class II or class III liquids. Electrical equipment used in the system shall be in accordance with NFPA30, section 5-7, wherein it states "For areas where class II or class III liquids only are stored or handled at a temperature below their flash points, the electrical equipment may be installed in accordance with provisions of NFPA70, National Electric Code, for ordinary locations..."
4. The system shall be designed and installed in accordance with applicable sections of NFPA30, NFPA31, NFPA37, UL80 and UL142. The day tank shall bear the label of Underwriters Laboratories standard 142 and UL508.
5. Installation General: The day tank shall be installed adjacent to the prime mover. Install as shown on the plan drawings, on a housekeeping pad adjacent to the prime mover. Anchor tank to the pad.
6. The mechanical contractor shall provide schedule 40, ASTM A 53, black iron pipe connections to the day tank as shown. Make all connections to fixed installed pipe with pipe unions to facilitate tank service/removal.
 - a. Supply to day tank, inlet to day tank pump
 - b. Day tank overflow to bulk supply
 - c. Supply and return to prime mover, as recommended by manufacturer.
 - d. Vent sizes shall be as shown and as required by local codes and by UL 142, NFPA31 and NFPA37 as well as project specification requirements.

7. Day tank ratings
 - a. Capacity: 100 gallons
 - b. Power requirements: 120V AC, single-phase, 60Hertz, 15A dedicated branch circuit
8. Day tank construction
 - a. All welded steel atmospheric tank of rectangular, double-wall secondary containment, welded construction built in accordance with codes and standards noted above for indoor use with fuel oil
 - b. Pipe thread connections shall be provided for fuel oil supply from main tank, supply to prime mover, return from prime mover, overflow to main tank, vents, and drain with fire rated ball valve. A weatherproof, screened vent cap shall be provided as a loose item for field installation at the outdoor vent termination. A weighted type emergency vent cap shall be supplied installed on the primary tank and secondary containment emergency vent ports.
 - c. The tank shall be equipped with a welded steel channel base suitable for bolt attachment to a concrete pad
 - d. The tank shall have interior corrosion inhibitor to deter corrosion prior to installation and use
 - e. The exterior of the day tank shall receive a heavy-duty industrial anti-corrosion coating and be finish painted
 - f. All day tank system components shall be protected by a removable or hinged steel equipment cover.
 - g. Day tank shall be factory leak tested at 3PSI.
 - h. The tank shall be steel double-wall secondary containment construction bearing the UL 142 label. The containment shall be equipped with a leak detector that shall activate the "leak" alarm described below. A drain with fire rated ball valve is to be supplied. The containment shall be equipped with a separate e-vent as required by UL 142.
 - i. Supply fire rated ball valves as follows:
 - 1) Day tank drain
 - 2) Secondary containment drain
9. Fuel delivery system: Provide and install on the day tank, a duplex fuel oil pump and duplex pump controller with automatic alternator for supply of fuel from the main tank to the day tank. This is a suction-lift application: adequate pipe sizes must be used in the system and a foot valve must be installed in the main tank if main is below level of day tank. Manual priming of the system is required.
 - a. Duplex pumps: shall provide 3 GPM at 1725 rpm, when operating with fuel oil having a viscosity of 32SSU.
 - b. Direct drive, motor driven pumps coupled via flexible coupling.
 - c. Motors to be TEFC construction, HP as required for pump at 50 PSI NEMA type B, continuous duty at 40°C, 1725 RPM, 120V AC, 60 hertz, 1.15 service factor
 - d. Pumps to be directly driven, positive displacement, internal gear type with mechanical shaft seal and cast iron body, machined steel gears.
 - e. Fire rated shutoff ball valves on pump inlets
 - f. Pump check valve, spring-type, cast iron construction
 - g. Flowswitch each pump

- h. Suction strainer, cast iron wye type fuel oil strainer on each pump suction
 - i. Provide a piston type, 0.1 gallon per stroke hand pump installed and piped and equipped with fire-rated shutoff valves.
10. Day tank testing
- a. The day tank shall be supplied with manufacturers test certificates as below Tank test: pressure test, leak proof test and structural integrity/appearance test
 - b. Level controller: operational test of level sensors, level indicator, level control, alarms, backup devices
 - c. Pump: vacuum test, flow test, pressure test, leak proof test, ampere/voltage test, load test, overload test.
11. Day tank manual
12. The day tank shall be supplied with an illustrated manufacturers manual that includes the following:
- a. Registration certificate
 - b. Glossary
 - c. Equipment list
 - d. Detailed description of operation
 - e. Pump specifications
 - f. Installation instructions
 - g. Troubleshooting instructions
 - h. Maintenance instructions
 - i. Piping diagram
 - j. Electrical drawing
 - k. Exploded view parts drawing/parts list
 - l. Dimensional drawing
 - m. Warranty card
13. Supply a manufacturer's 2-year field service warranty which covers all parts and all labor for guarantee of parts and workmanship as specified herein.
14. The day tank system, shall be designed and manufactured by a single supplier and be a standard product in serial production. The manufacturer shall have at least 10 years experience in the design and manufacture of these products. This system shall be a Model SRS Packaged Design Fuel Oil Day Tank as manufactured by Simplex, Inc., Springfield, Illinois.
15. Shop Drawings
- a. Submit shop drawings for approval. Submit operating manuals as described in other sections of the project specifications.
 - b. Provide two (2) hours on site training for Owner's personnel.

PART 3 - EXECUTION

3.1 GENERAL

- A. Shop drawings shall be submitted for all equipment specified in this section of the specifications.

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General Services Division, State of West Virginia
Charleston, West Virginia

- B. Contractor shall have qualified factory representative provide four(4) hours on site training for Owner's personnel.
- C. Equipment specified can be supplied by George Reitz, Inc. Contact Mr. Dick McLaughlin, telephone no. 814-849-2308.

END OF SECTION 263215

SECTION 28 1300 – ACCESS CONTROL SYSTEM

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 and the other sections of Division 28.
- B. Specification 08 71 00, Door Hardware.
- C. Specification 08 71 13, Automatic Door Operators.

1.2 DRAWINGS

- A. The drawings show the general arrangement and extent of the work only. Determine the exact location and arrangement of all parts as the work progresses.
- B. In all details, the work shall be subject to the Owner's direction and approval. All work shall conform to its surroundings in best possible manner.

1.3 SCOPE OF WORK

- A. The following Section includes the procurement, installation, and configuration of an access control system (card key system). This section also includes all cabling, door hardware, contacts, raceways, enclosures, electrical power outlets, and other infrastructure required to provide a complete operating system. The connection and coordination to provide remote signaling and control is also included. Systems shall be installed complete with all power supplies, software, batteries, and lockable enclosures.
- B. System shall interface with door hardware as specified in section 08 71 00 using Ingersoll Rand Schlage access control panels and modules and also interface with Owner's current GE Facility Commander System.
- C. System shall interface with the Video Surveillance system to the fullest extent of capabilities offered by the Ingersoll Rand Schlage and must interface with the state-wide GE Facility Commander system, providing presets and alarm state camera window call-up.

1.4 SUMMARY OF ACCESS CONTROL SYSTEM

- A. General: The work covered by this section of the specification consists of furnishing all labor, material, equipment and appliances and of performing all operations in connection with the installation of a complete and operating access control system in strict accordance with all the applicable codes, instructions and diagrams as required by law and this specification.
- B. Specific: Without intending to limit and/or restrict the scope of work required by this specification and all applicable drawings and solely for the convenience of the Contractor the work to be performed in general consists the following:
 - 1. Mounting all door hardware, contacts, electronic control devices, request-to-exit devices, and related field materials supplied by Security Contractor for the complete installation of the access control system.

2. Terminations of all wiring and cables as required for the complete installation and operation of the access system including all hardware shall be provided by the security contractor.
3. Connection of all electronic devices supplied in section 08 71 00 including but not limited to power transfer hinges, integrated card readers, door position switches, etc.
4. Hardware mounting is to be performed per manufacturers instructions and all applicable codes and laws.
5. Material: All materials shall be new and be shipped to the project site and stored in original manufactures containers.
6. Quality Assurance: All powered equipment shall be UL listed.
7. Requirements of Regulatory Agencies: All exit devices must be listed under 'Panic Hardware' in Accident Equipment List of Underwriters Laboratories. Where labeled fire doors are used as exits, they must be equipped with labeled fire exit hardware.
8. The duress buttons shall be programmed to initiate the sounding of a designate number of door sounders. Coordinate precise action with owner.

1.5 SUBMITTALS

- A. A completely itemized hardware schedule and complete Ingersoll Rand Schlage Access Systems and GE Security parts list, coordinated with the schedule below, shall be provided.
- B. Product Data: Specifications, data sheets, certified drawings, catalog, stock numbers and installation instructions. Include all manufacturers names on cut sheets. Highlight specific products.
- C. Samples, if required by the Consultant or Owner, include one (1) representative piece of each item of hardware requested. Tag samples to show their intended use. Samples will be retained by the Owner until the project is nearly completed, at which time they may be incorporated into the work.
- D. All hardware schedules submitted for approval must be in a vertical format. Hardware schedules submitted in a horizontal format are unacceptable and will be returned unchecked.

PART 2 - PRODUCTS

2.1 Requirements:

- A. Security equipment shall consist of the appropriate configuration of Ingersoll Rand Schlage door hardware equipment to accomplish the intended functions. It is the responsibility of this contractor to coordinate all necessary hardware/software with the manufacturer.
- B. Should items of hardware not specified be required for completion of the work, furnish such items of types and quantities suitable for the service required and comparable to adjacent or similar hardware. All equipment shall be the latest available version of the manufacturer.
- C. Should it be determined that specified hardware for any location, because of detail or size of member to which the hardware is to be applied, is unsuitable, provide hardware of the proper type. Such hardware will be similar in operation to types specified and not of lesser quality.
- D. Screws: Phillips head screws.
- E. Finishes: As specified in schedule.

2.2 Materials: Hard-wired System

- A. Furnish Ingersoll Rand Schlage Systems & GE Security Systems, No Substitution. Refer to Specification Sections 08 71 00, Door Hardware and 08 71 13, Automatic Door Operators.
- B. The access control system shall include the following features:
1. Modular: Uses Expansion boards
 2. Stand alone or networked
 3. Microprocessor based
 4. Digital Transmission
 5. Encryption
 6. Local operating program
 7. Multiple reader technologies
 8. Resident Application Library
 9. UL Listed: 294, 1076, Grade AA
 10. Relay outputs
- C. Control Panels: - GE Security, M5, M2000 and M3000 PNXplus series as appropriate. The control panels shall be intelligent and fully stand-alone processor capable, making all local access control and alarm monitoring decisions without host server dependency. Control panels shall support and provide the following:
1. UL listed under UL 294 and UL 1076; FCC Part 15 and CE compliant.
 2. Direct on-board support for industry standard RS232, RS422, Dial-up modem AT command set, and 10/100Mb Ethernet communications interfaces to ISMS host.
 3. The 10/100Mb Ethernet NIC shall be onboard and support IT standard methods of communications with ISMS host including configuration support for static IP addressing, dynamic DNS, DHCP and DES encryption. PCMCIA Adapters or external terminal server devices will not be acceptable.
 4. Support redundant communications to ISMS host; primary communications via 10/100Mb Ethernet with automatic switchover to secondary communications via dial-up modem when detecting network failure.
 5. RS232 and RS422 communications ports for cascading/clustering multiple control panels via a single communications port interface to ISMS host.
 6. Flashable memory support for facilitating remote firmware updates from ISMS host server and operator workstations; control panels shall remain on-line and operational during firmware update process.
 7. The control panel shall be able to be configured & diagnosed remotely through a standard browser interface, independently of the ISMS host application.
 8. The control panel shall support local database retention in the event of power failure, without the use of batteries that have to be replaced. Minimum retention without primary power source shall be 20 days. When primary power is restored, the control panel shall automatically attempt to establish communications with the ISMS host, in the event communications to ISMS host is not available, the control panel shall automatically return to operation with its last local database configuration.
 9. Control panel cabinets shall be an industrial grade enclosure with knockouts for field wiring and have a key-locked and tamper protected door
 10. Low voltage power supply with uninterruptible battery backup allowing continued operations for a minimum of 4 hours at full load
- D. Control Panel Interface Boards: The ISMS control panels shall support on board and/or expansion interface boards for access control readers, alarm monitoring, and input/output control. Control panels shall support and provide the following as required:

1. Access Control Reader Interfaces:
 - a. Shall support hard-wired connections to readers, including power and communications. Connections shall be supported at a minimum distance of 2,000ft. (610m) Utilizing 22AWG 2-pair shielded and unshielded cabling.
 - b. Shall support supervision, monitoring, and processing of the following:
 - 1) Reader tamper and communications.
 - 2) Status changes from locally wired door sensor and request to exit device.
 - c. Shall support card only and card-plus-keypad style readers of the following technologies:
 - 1) Proximity.
 - 2) Smart Card.
 - 3) Magnetic Stripe.
 - 4) Wiegand.
 - 5) Barcode.
 - 6) BaFe Touch.
 - 7) Biometrics.
 2. Input / Output Point Interfaces:
 - a. Shall support 4-State supervised alarm inputs.
 - b. Shall support relay and TTL level output points.
- E. Access Control Card Readers:
1. Reader Technology: As specified by selected card technology and application requirements; compatible with ISMS control panels and commercially available from industry leading manufactures that include but not limited to:
 - a. GE Security.
 - b. HID.
 - c. Other approved equals.
 2. The specified card and reader manufacturer shall support a full product line that offers multiple models and/or styles to fit various installation and application requirements including:
 - a. Multi-technology readers that will read Proximity, Vicinity, and Mifare Smart Card credentials simultaneously.
 - b. Card only and card-plus-keypad style readers.
 - c. Rugged, weatherized enclosures rated for indoor and outdoor mounting.
 - d. Rated for mounting on metal and non-metal surfaces.
 - e. Provide audible and visual indicators for reader status and validation of granted and denied access.
 3. Provide quantities for each model and/or style indicated on drawings. Single Reader Interface Module (SRI)
- F. Control Panel Capacities:
1. Field Configurable Control Panel:
 - a. Card Readers: Capable of supporting up to 16 card readers.
 - b. General Purpose Alarm Points: Capable of supporting up to 80 four-state supervised alarm input points.
 - c. General Purpose Outputs: Capable of supporting up to 64 relay or TTL level output points.
 - d. Access Control Card Memory: Up to 100,000
 - e. Offline-History Transaction Buffer: Up to 16,000
 - f. Time Schedules: Up to 1,024
 - g. Access Rights: Up to 96 per access control card per panel
 - h. Uninterruptible Power Supply: Battery rated for a minimum 4 hours of continuous operation at full load.
 2. Fixed Configuration Control Panel:
 - a. Card Readers: Support 4 card readers.
 - b. General Purpose Alarm Points: Support 10 four-state supervised alarm input points.

- c. General Purpose Outputs: Support 8 relay output points.
- d. Access Control Card Memory: Up to 100,000.
- e. Offline-History Transaction Buffer: Up to 16,000.
- f. Time Schedules: Up to 1,024.
- g. Access Rights: Up to 96 per access control card per panel.
- h. Uninterruptible Power Supply: Battery rated for a minimum 4 hours of continuous operation at full load.

G. Input/Output Control

- 1. The ISMS shall allow control panel input and output points to be individually defined, configured, and controlled in the following manner:
 - a. Input point(s) shall be user configurable for specific applications. The following application types shall be supported:
 - 1) Alarm: digital input used to trigger an alarm and any selected output.
 - 2) Digital Output: digital input used to trigger a selected input without alarm notification.
 - 3) Elevator: digital input used for elevator control.
 - 4) Inactive: digital input is disabled.
 - b. Input point(s) shall support a user configurable sense time from 0 to 59 minutes and 59 seconds. Sense time changes shall be supported via event schedules.
 - c. Input point(s) shall allow the active state to be configured as open or closed.
 - d. Input point(s) shall be user configurable to control a primary and/or secondary output. Input point(s) configured for output control shall allow being enabled or disabled via time schedule.
 - 1) The primary output shall be configurable to follow the input point's state change or activate for its defined output duration.
 - 2) The secondary output(s) shall be configurable to follow the input point's state change or remain activated until manually reset or scheduled off.
 - e. Output point(s) shall support a user configurable duration time from 0 to 61 minutes and 59 seconds.
 - f. Output point(s) shall allow the active state to be configured as on or off.
 - g. Output point(s) shall be automatically controlled via time schedule to turn on or off.
 - h. Output points shall allow grouping to facilitate activating multiple outputs points, on or off, via time schedule.
 - i. Output point(s), including reader controlled doors, shall allow manual control by authorized operators in the following manner:
 - 1) Activate/unlock for duration.
 - 2) Activate/unlock indefinitely.
 - 3) Deactivate/Lock.
 - 4) Schedule override.
 - 5) Text entry explaining reason for manual operator control shall be recorded in operator history/archive database.

H. Power Supplies shall be Ingersoll Rand, Altronix or approved equal:

- 1. Supplied with 4 hr battery backup
- 2. Supply battery calculations as a submittal
- 3. Coordinate power supply parameters with manufacturers of equipment being supplied power.
- 4. 12 VDC power supplies shall be Altronix Model AL1012ULXPD16CB or approved equal.
- 5. Supply power supplies complete with fresh batteries
- 6. Supply power supplies for the initial load plus 30% spare capacity including batteries.
- 7. Mount on walls in Server Room and Telecom Rooms.

- I. Wire and cable to hard-wired electronically monitored and controlled doors shall be:
1. Typical Access Control Cable = (4) individually shielded cables may be supplied individually or in a bundle with suitable overall PVC jacket rated CM or CMP as per the environment in which it is to be placed.
 2. Door Strike = red foil or red jacket = (4) conductor 18AWG fabricated from 16 strand 30AWG bare copper with overall aluminum/foil shield and drain wire. Conductor colors: black, red, white, & green using a 3" lay length.
 3. Card Reader = white foil or white jacket = (3) pairs 18AWG fabricated from 16 strand 30AWG bare copper with overall aluminum/foil shield and drain wire. Pair colors: black/red, green/white, orange/blue. Each pair has a 2" lay length and the bundle has a 4.5" lay length.
 4. Door Contact = blue foil or blue jacket = (2) conductor 22AWG fabricated from 7 strand 30AWG bare copper with overall aluminum/foil shield and drain wire. Conductor colors: black & red using a 1-3/4" lay length.
 5. REX = green foil or green jacket = (4) conductor 22AWG fabricated from 7 strand 30AWG bare copper with overall aluminum/foil shield and drain wire. Conductor colors: black, red, white, & green using a 2" lay length.
 6. Typical integrated door hardware Card Reader, Door Contact, REX, tamper switch, and Door Strikes = white foil or white jacket = (2) conductor shielded 24AWG cable for RS-485; plus chrome jacket = (2) conductor with shield 18AWG stranded wires.
- J. Cable Protection
1. All cables exiting the building shall have class 2 protection provided. Mount protection on wall.
 2. Each cable pair shall be protected with building entrance protectors at each end sized for the specific cable. Individual plug-in protector modules shall be provided for each pair. Products shall be Avaya/Lucent Type 489 with 110 connectors and 5 pin solid state protectors with heat coils.

PART 3 - EXECUTION

3.1 WORKMANSHIP

- A. General: Arrange work to obtain coordinated installation with proper clearances and systems neatly spaced.
- B. All wiring must be kept a minimum of 12" from any parallel run AC circuit or electrical devices including lighting and fluorescent fixtures.
- C. All shield and grounds must be properly installed and terminated separately from all other grounds, as specified by manufacturers instructions.
- D. Junction boxes are to be supplied wherever splices are made throughout the system. Wiring shall be individually labeled and junction boxes shall be labeled with indelible markers with lettering .5 in. minimum.

3.2 PRODUCT HANDLING:

- A. Protect materials and equipment from damage, water and rust during storage and after installation.
- B. Close openings of conduits, boxes, cabinets, outlets and equipment to prevent entry of foreign matter.
- C. Protect finish surfaces until in service.

3.3 INSTALLATION:

- A. Apply and install hardware in accordance with the best trade practice.

- B. Secure bumpers to walls with toggle bolts or expansion shields as required by wall or partition construction.
- C. All custom software becomes the property of the Owner upon acceptance with no special or hidden keys preventing updating of software.
- D. All alarms to be reported to the Security Office.
- E. All signaling and control link equipment shall be provided. The link shall be provided by the Owner. All interconnect electronics and cable jumpers are to be provided and installed by the Contractor.
- F. All reported alarms shall interact with CCTV camera coverage directing PTZ outdoor cameras to the part of the building indicated by the zone and bring up the nearest camera, on the spot monitoring.
- G. All user ID card information shall be loaded into the controllers.
- H. All PIR units shall be masked to prevent false alarms from sources such as heaters.
- I. Mount PIR units on suspended ceiling or stem mount where no suspended ceiling exists. Avoid all obstructions such as mechanical ductwork, piping, cable baskets etc.
- J. Install all access control products in NEMA 1 lockable enclosures. Provide the owner with two sets of keys for each enclosure. Keys shall be labeled with the same numbering scheme as the enclosures.

3.4 CLEAN AND ADJUST:

- A. Take care not to mark or damage adjacent work. Repair or replace damaged work to the Consultant or Owner's satisfaction.

3.5 SOFTWARE CONFIGURATION:

- A. All software programming to ensure a complete and operational system shall be performed as part of this contract. Software shall be upgraded to the latest available version at time of acceptance.

3.6 TESTING:

- A. Test each and every piece in front of the owner or owner's representative. Provide a schedule to the owner 72 hours prior to testing. Cabling shall be tested for continuity and every feature of each piece of equipment shall be tested. Failed equipment shall be repaired and retested.

3.7 WARRANTY:

- A. Special Warranty
 - 1. Proximity Access Readers: Proximity readers shall provide a lifetime warranty against workmanship and defects.
 - 2. System Components: One (1) year from date of Substantial Completion.
 - 3. Labor: One (1) year from date of Substantial Completion.
- B. Reference manufacturer warranty for further details.

END OF SECTION 281300