

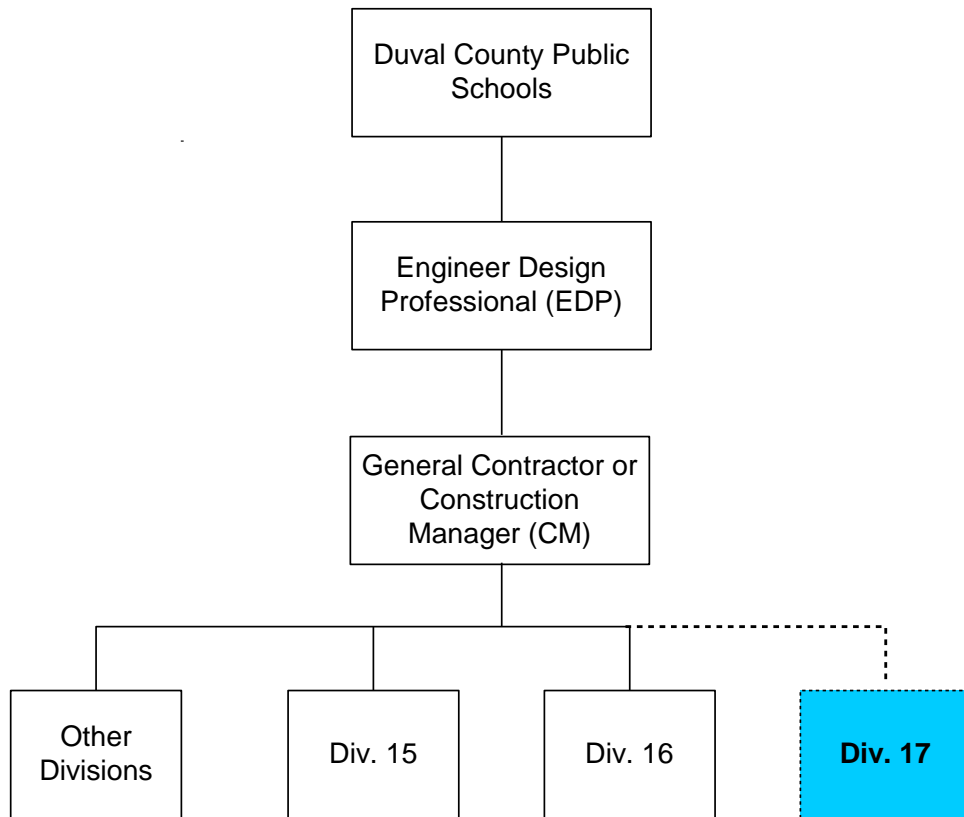
## PART 1 - GENERAL

## 1.1 SCOPE OF WORK

- A. The work covered by this section includes shop drawings, plans, equipment, labor, materials, engineering, technical supervision, programming, set up (including inputting operating schedules, holidays, etc.) and transportation as required for a fully operational, energy conservation-minded, turnkey Energy Management and Control System (EMCS).
1. The EMCS basic design by the Engineering Design Professional (EDP) consists of the Input/Output (I/O) Summary Point List, control system schematics and wiring diagrams, and energy efficient control sequences of operations, all shown on the drawings.
  2. Provide only EMCS software previously selected for Duval County Public School projects. The EMCS Contractor and Owner maintain a library of current software.
  3. Smoke detectors and combination fire/smoke dampers and their associated control/interlock wiring are work of another section.
- B. The terms for the parties involved in the engineering, design, procurement and installation of the EMCS are:
1. Owner: The Duval County Public Schools (DCPS). The Owner's contact is: Duval County Public Schools , Project Manager.
  2. Engineering Design Professional (EDP): The professional firm whose direct responsibility is the engineering design and construction administration of the EMCS. This EDP may be the firm with whom the Owner has a Professional Agreement, or may be a sub-professional to the firm. Data on the firm is shown on the controls drawing.
  3. Energy Management & Control System (EMCS) Contractor: The EMCS Contractor shall provide all hardware, software, other material, equipment, and labor required for a complete system, including all control devices, wire, conduit, installation, start-up, set up, commissioning, warranty and service described in the contract documents. The EMCS Contractor shall be a manufacturer's authorized representative for:
    - a. Alerton
    - b. Automated Logic
    - c. Andover
  4. Prime Contractor: The party with whom the Owner has a construction contract agreement for this project.

- 1.2 General Conditions, Supplementary Conditions, General Requirements, and other provisions and requirements of the contract documents apply to work of Division 17, Energy Management and Control Systems.
- A. Investigate all alternates, addenda and allowances as they relate to work of Division 17.
  - B. All Division 17 scope of work sections shall be considered to be integrated with each other and will be the responsibility of the EMCS Contractor.
  - C. Consider the terms "provide" and "install" as synonymous with "furnish and install".
  - D. Any and all questions about the EMCS Contractor's scope of work responsibility shall be addressed to and answered by the (General Contractor) (Construction Manager).
  - E. The EMCS Contractor shall examine drawings relating to work of all trades and become fully informed as to extent and character of work required and its relation to all other work in the project.
  - F. Before submitting pricing, the EMCS Contractor shall visit the site and examine all adjoining existing buildings, equipment and space conditions on which his work is in any way dependent for the best workmanship and operation according to the intent of specifications and drawings. He shall report to the EDP any condition that might prevent him from installing his equipment in the manner intended.
  - G. No consideration or allowance will be granted for failure to visit site, or for any alleged misunderstanding of materials to be furnished or work to be done.

1.3 DIVISION 17000



1. Division 17 pricing and proposed EMCS Contractor shall be clearly indicated in the CG/CM bid documents for DCPS review.
2. All Division 17 invoices to be submitted through GC/CM and approved by Engineer Design Professional (EDP).
3. Division 17 will be operationally responsible to the GC/CM.
4. Division 17 is responsible for complete EMCS installation (turnkey).

1.4 QUALITY ASSURANCE

- A. EMCS Contractor shall be responsible for all EMCS engineering, programming, graphics generation, system set up and cooperation with system commissioning agent related to the EMCS.
- B. The EMCS Contractor shall have local maintenance capabilities available within Duval County.

- C. All work shall be performed by specially trained personnel in the direct employ of the EMCS Contractor who have received special training and are proficient on the EMCS manufacturer's equipment for the required tasks (programming, installation, commissioning, training, etc.). If the Owner or EDP are not satisfied with the quality or have any issues with the personnel assigned to the project by the EMCS Contractor, the EMCS Contractor shall provide other personnel who are acceptable to the Owner and/or EDP.

#### 1.5 CONTRACT DRAWINGS

- A. Examine all drawings and specifications carefully before submitting a bid. Architectural drawings (and existing conditions) take precedence over mechanical, automation or electrical drawings with reference to building construction. If discrepancies or conflicts occur between drawings, or between drawings and specifications, notify the EDP immediately. If notification is received within adequate time, a change will be issued by addendum. If not, the more stringent requirement takes precedent.
- B. For purposes of clearness and legibility, drawings are essentially diagrammatic and, although size and location of equipment are drawn to scale wherever possible, EMCS Contractor shall make use of all data in all of the contract documents and shall verify this information at the building site.
- C. The drawings indicate required size and points of termination of pipes, conduits and ducts and suggest proper routes to conform to structure, avoid obstructions and preserve clearances. However, it is not intended that drawings indicate all necessary offsets, and it shall be the work of the EMCS Contractor to make the installation in such a manner as to conform to structure, avoid obstructions, preserve headroom and keep openings and passageways clear, without further instructions or cost to the Owner.
- D. Furnish, install and/or connect with appropriate services all items shown on any drawing without additional compensation.
- E. The drawings and specifications are complimentary; and the work required by either shall be included in the Contract as if called for by both.
- F. If directed by the EDP, the EMCS Contractor shall, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades or for proper execution of the work.
- G. Changes that are required or desired which are materially different from the obvious intent of the drawings or specifications will not be permitted except for those instances where it is necessary to avoid interferences and only where specifically approved by the EDP.
- H. The EDP reserves the right to make reasonable changes in location of all EMCS equipment prior to roughing in and final placement.

#### 1.6 DEMOLITION (Include section as required)

- A. Unless otherwise noted, remove all control materials and equipment from areas indicated for demolition.

- B. Remove unused conduit to the extent necessary to accommodate new work and where conduit is visible above the floor line. Existing unused conduit which is concealed, or which does not interfere with the work, may remain in place. Seal abandoned lines that remain in place behind walls or floor surfaces. Remove existing unused wires.
- C. EMCS materials and equipment to be demolished, except items specifically listed to be relocated or delivered to the Owner, become the property of the EMCS Contractor.
- D. Existing EMCS connections to items being removed by others must be disconnected by the EMCS Contractor.
- E. Remove all associated wiring and devices from equipment indicated for removal.

#### 1.7 CODE REQUIREMENTS AND STANDARDS

- A. Perform work in accordance with applicable statutes, ordinances, codes, and regulations of governmental authorities having jurisdiction. Applicable codes include the following
  - 1. American National Standards Institute (ANSI).
  - 2. National Electrical Code (NEC).
  - 3. National Electrical Manufacturers Association (NEMA).
  - 4. National Fire Protection Association (NFPA).
  - 5. Underwriters' Laboratories (UL).
  - 6. Occupational Safety and Health Regulations (OSHA).
  - 7. Local, State and National Codes, Standards and Ordinances.
- B. Resolve any code violation discovered in contract documents with the EDP prior to award of the contract. After award of the contract, make any correction or addition necessary for compliance with applicable codes at no additional cost to Owner/EDP.
- C. Where there is a conflict between the contract documents and an applicable "CODE", the "CODE" shall govern except where the requirements of the contract documents are more stringent; where there is a conflict between the contract drawings and the contract specifications, the most stringent shall govern.

#### 1.8 PERMITS, FEES AND INSPECTIONS

- A. Obtain all permits, fees and systems inspections.
- B. Deliver all certificates of inspection issued by authorities having jurisdiction to the GC/CM.

**1.9 REFERENCE SPECIFICATIONS AND STANDARDS**

- A. Materials which are specified by reference to Federal Specifications; ASTM, ASME, ANSI, or AWWA Specifications; Federal Standards; or other standard specifications must comply with latest editions, revisions, amendments or supplements in effect on date bids are received. Requirements in reference specifications and standards are minimum for all equipment, material and work. In instances where capacities, size or other feature of equipment, devices or materials exceed these minimums, meet listed or shown capacities.
- B. EMCS Contractor responsible for applicable scope specified in section 01810 General Commissioning Requirements and its associated specifications.

**1.10 SUPERVISION OF WORK**

- A. Perform all EMCS work under the direct supervision of the EMCS Contractor's experienced, qualified superintendent. The EDP, GC/CM or the Owner has the right to remove a superintendent who, in his opinion, is not satisfactory.

**1.11 WORKMANSHIP**

- A. Install materials and equipment in a professional manner. The EDP or Owner may direct replacement of items that, in his opinion, do not present a professional appearance. Replacement or reinstallation of these items shall be at the expense of the EMCS Contractor.

**1.12 CONNECTING TO WORK OF OTHERS**

- A. Examine all work installed by others where it applies to work of Division 17. Notify the EDP if conditions exist which prevent satisfactory results. Start of work shall be construed as acceptance by him of all claims or questions as to suitability of the work of others to receive his work.

**1.13 DAMAGE TO OTHER WORK AND PERSONNEL**

- A. Adequately protect work, equipment, fixtures, and materials. At work completion, all work must be clean and in good condition.
- B. Carry insurance as prescribed by law and as required in this specification for protection of employees, other persons, materials and equipment on the building site.
- C. EMCS Contractor shall pay for all damages caused by his personnel, including his subcontractors.

**1.14 CUTTING AND PATCHING**

- A. Cut and patch all walls, partitions, floors, pits and chases in wood and masonry as indicated or required by the contract documents or as directed by the GC/CM. However, this may be excluded from the EMCS Contractor's scope of work if agreed upon in writing with the CG/CM.

- B. Obtain approval of EDP and GC/CM prior to cutting of steel, wood or other structural member.
- C. Complete all necessary excavation and backfilling incidental to work of Division 17.
- D. "Fire and Smoke Rated" Walls, Floors, Roofs and Ceilings. Where "rated" walls, floor, roofs and ceilings are penetrated or cut to install equipment, materials, devices, etc. the EMCS Contractor shall provide and install all materials required to re-establish the rating of the wall, floor, roof or ceiling to the satisfaction of the authority having jurisdiction.

#### 1.15 CLEANING

- A. The EMCS Contractor shall clean up all debris resulting from his/her activities daily. The EMCS Contractor shall remove all cartons, containers, crates, etc., under his control as soon as their contents have been removed. Waste shall be collected and placed in a designated location.
- B. At the completion of work in any area, the EMCS Contractor shall clean all work, equipment, etc., keeping it free from dust, dirt, and debris, etc.
- C. At the completion of work, all equipment furnished under this section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired to match the adjacent areas. Any cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

#### 1.16 CONCEALED WORK

- A. Where the word "concealed" is used in connection with insulating, painting, piping, ducts, conduit, wiring and the like, the word is understood to mean hidden from sight as in chases, furred spaces or above suspended ceilings. "Exposed" is understood to mean open to view.

#### 1.17 OBSTRUCTIONS

- A. The drawings indicate certain information pertaining to surface and subsurface obstructions, which has been taken from available drawings. Such information is not guaranteed, however, as to accuracy of location or complete information.
- B. Before any cutting or trenching operations are begun, verify with Owner, utility companies, municipalities, and other interested parties that all available information has been provided. Verify locations given.
- C. Should obstruction be encountered, whether shown or not, alter routing of new work, reroute existing lines, remove obstruction where permitted, or otherwise perform whatever work is necessary to satisfy the purpose of the new work and leave existing services and structures in a satisfactory and serviceable condition.
- D. Assume total responsibility for and repair any damage to existing utilities or construction, whether or not such existing facilities are shown.

#### 1.18 SPACE REQUIREMENTS

- A. Consider space limitations imposed by contiguous work in selection and location of equipment and material. Do not provide equipment or material that is not suitable in this respect.

#### 1.19 MATERIALS AND EQUIPMENT

- A. Use new products the manufacturer is currently manufacturing and selling for use in new installations. Do not use this installation as a product test site unless explicitly approved in writing by Owner. Spare parts shall be available for at least five years after completion of this contract.
- B. Only products specified hereinafter or listed in an addendum, prior to the acceptance of bids, shall be furnished and installed under this contract.

#### 1.20 SUBSTITUTIONS AND PRIOR APPROVAL

- A. No substitutions will be considered unless written request has been submitted and received by the EDP at least ten calendar days prior to the date for receipt of bids. Include information identical to shop drawing submittals with the request.
- B. Substitutions submitted after the prescribed time for prior approval will not be considered.
- C. All substitutes or alternate manufacturers' products must meet detailed specifications, size and arrangement of equipment specified. Equipment must fit allocated space. Only products equal to that specified will be considered.
- D. If the approved substitution contains differences or omissions not specifically called to the attention of the Owners Representative, the Owner reserves the right to require equal or similar features to be added to the substituted product at the EMCS Contractor's expense.

#### 1.21 ADDITIONAL WORK

- A. Design is based on equipment as described in the drawings and specifications. Any change in foundation bases, electrical, wiring, conduit, connections, piping, controls, openings, etc. required by alternate equipment specified and submitted and approved shall be paid for by the EMCS Contractor.

### PART 2 - SHOP DRAWINGS

#### 2.1 SUBMITTALS:

- A. For all new installations, EMCS Contractor shall submit through the GC/CM for EDP and Owner approval a complete list of equipment and materials, including product data sheets, description of program software and installation instructions, and shop drawings. Shop drawings shall contain complete wiring, routing and schematic diagrams and any other details required demonstrating that the system has been coordinated and will function properly. Include valve and damper schedules showing pressure drops, actuators, temperature sensors, flow meters, pressure sensors and safety switches. Information shall include electrical requirements of equipment.

- B. Shop drawings shall show layout and installation of all EMCS equipment and appurtenances. The EDP shall furnish the EMCS Contractor with one set of reproducible floor plans so that the EMCS Contractor may indicate locations of equipment. Equipment relationships to other parts of the work shall also be shown.
- C. The EMCS Contractor shall submit through the CG/CM schematic wiring diagrams for each type of equipment being controlled.
- D. The EMCS Contractor shall include a complete set of shop drawings covering items for which he is responsible for providing. Submit seven copies of the manufacturer's printed specifications and shop drawings for each item. Include the following information - dimensions; electrical characteristics; materials of construction; finish; guarantee; other information deemed necessary by the manufacturer.
- E. Control drawings with detailed ACAD piping and wiring diagrams, including bill of material and description of operation for all systems. Control drawings shall be a minimum of 11" X 17" in size. Installation/layout drawings shall be generated using the current revision of AutoCAD.
- F. Provide a letter certifying that all equipment submitted complies with the contract documents and will physically fit in the space allocated.
- G. Shop drawings shall be submitted. Indicate by approved signed stamp that the drawings have been checked, that the work shown on the drawings is in accordance with contract requirements and that dimensions and relationship with work of other trades have been checked. If drawings submitted for approval have not been checked and signed by the GC/CM, they will be returned before being considered by the EDP. Each shop drawing submitted shall indicate the submittal number.
- H. Manufacturer recommended grounding and surge suppression or power conditioning to be submitted.
- I. Energy conservation minded EMCS set up parameters shall be submitted.

## 2.2 FINAL SUBMITTAL

- A. In addition to number of copies of shop drawings and other data required for review submittals, maintain a separate file of final approved copies of such material. Deliver approved copies in a hard-back binder for the Owner's use. Incorporate changes and revisions made throughout construction period. Delivery of approved copies is a condition of final acceptance for the project.

## 2.3 TRAINING AND INSTRUCTION

- A. EMCS Hardware: The EMCS Contractor shall provide the services of a technician who is familiar with the installed EMCS system and who can demonstrate to the Owner the physical location, function and operation of all EMCS hardware and software, as well as maintenance and troubleshooting techniques that are specific to this installation.

- B. Instructions to Owner: Provide the services of competent instructors who will give full instruction to designated personnel in the operation and maintenance of the EMCS. Orient the training specifically to the system installed. Instructors shall be thoroughly familiar with the subject matter they are to teach.
- C. Provide a training manual for each student at each training phase that describes in detail the data included in each training program. Provide one additional copy for archiving.
- D. Provide one 2-hour training session for Owner maintenance staff during installation of EMCS system while equipment is exposed and ceilings are open.
- E. Instructions shall be provided to the Owner prior to systems cutover on renovation projects.
- F. Provide two 4-hour training sessions on-site at a time and place determined by the Owner. Training will include all EMCS functions including, but not limited to operation, troubleshooting, scheduling, trends, programming, set up and graphics generation.
- G. Provide training for up to 10 maintenance personnel.

#### 2.4 OPERATING AND MAINTENANCE MANUALS AND DOCUMENTATION

- A. The EMCS Contractor shall provide to the GC/CM two comprehensive site-specific operation and maintenance manuals on equipment and software provided by the EMCS Contractor. These manuals shall include approved submittals, controls drawings, written sequence of operations, logic diagrams, software documentation, start-up procedures, failure and recovery procedures, preventative maintenance procedures, set up parameters, system access requirements, etc. Copies of as-built control and schematic wiring diagrams for each type of equipment and floor plan drawings showing the as-built physical location of EMCS hardware and routing of conduit and wiring shall be contained in each manual.
- B. Framed control drawings to include approved EMCS sequences of operation and sequences of operation shall be provided and installed in all HVAC equipment rooms. Drawings shall cover all equipment in the equipment room and also include typical associated equipment such as FTUs or VAVs for VAV AHUs. Frames shall be securely mounted with screws but shall allow control drawings to be replaced as they may be updated. Drawings shall be a minimum of 11" X 17" in size.
- C. The EMCS Contractor shall be responsible for providing two sets of all operating and maintenance manuals and documentation in electronic PDF format on compact disk. These must be complete in every respect. In addition, all documentation such as drawings, software, logic diagrams, etc. that were generated for this project shall also be provided in its native format (Auto-CAD, Visio, Word, etc. files) in electronic format on compact disk (two sets) in order that they may be saved and modified in the future.

#### 2.5 INSTRUCTIONS

- A. Included within the scope of Division 17 is work where equipment and/or materials are furnished or required by this Division and installed under another Division (designated by the GC/CM). It is the responsibility of the EMCS Contractor and GC/CM to see that all such work is included in the contract bid amount and completed during construction.

- B. All control wiring and conduit shall be furnished and installed by the EMCS Contractor, except where otherwise noted.

## 2.6 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver and store equipment and products in factory wrapped packages that properly protect equipment against weather, dirt, damage and electrostatic discharge.
- B. Handle equipment carefully to avoid damage to motors, components, enclosures and finish. Do not install damaged units; replace and return damaged units to manufacturer.

## PART 3 - PRODUCTS

### 3.1 EMCS HARDWARE UNITS

- A. Command, Controller and Interface Units: Command, Controller and Interface Units shall be provided as a networking stand-alone energy management system including micro-computers, network communications ports, power supplies, non-volatile double EPROM memory and battery backup and necessary software. Command Units shall be connected to Controller Units with sufficient points to provide the control and monitoring required for the equipment and devices assigned to them. Controller Units may be integral with Command Units or may be stand-alone modules connected to a Command Unit, complete with non-volatile double EPROM. Interface units shall be provided as necessary to permit data communication to Operator's Units.
- B. Enclosures: EMCS hardware units, power supplies, terminal strips, relays, etc. shall be enclosed in a sturdy NEMA-rated enclosure with durable finish and locking hinged door. Enclosures shall have durable nameplates secured to the front indicating that it is an EMCS Panel and the equipment or area that it serves. An exception is that EMCS hardware units may be mounted inside suitable factory enclosures that are provided within controlled equipment (VAV boxes and Unit Ventilators for example).
- C. Operator's Units: As an interface device, an operator shall be able to communicate from any computer accessible to the Owner's network. For all new installations, the EMCS Contractor shall provide fully developed user-friendly graphics software, customized for the project.

### 3.2 Communication

- A. Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a BACnet internetwork. Controller and operator interface communication shall conform to ASHRAE/ANSI Standard 135-2001, BACnet.
- B. Use existing Ethernet backbone for network segments marked "existing" on project drawings.
- C. Each controller shall have a communication port for temporary connection to a laptop computer or other operator interface. Connection shall support memory downloads and other commissioning and troubleshooting operations.

- D. Internetwork operator interface and value passing shall be transparent to internetwork architecture.
  - 1. An operator interface connected to a controller shall allow the operator to interface with each internetwork controller as if directly connected. Controller information such as data, status, and control algorithms shall be viewable and editable from each internetwork controller.
  - 2. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be readable by each controller on the internetwork. Program and test all cross-controller links required to execute control strategies. An authorized operator shall be able to edit cross-controller links by typing a standard object address or by using a point-and-click interface.
- E. All devices with real-time clocks shall use the BACnet Time Synchronization service. EMCS shall automatically synchronize system clocks daily from an operator-designated controller via the internetwork. If applicable, system shall automatically adjust for daylight saving and standard time.
- F. EMCS shall be expandable to at least twice the required input and output objects with additional controllers, associated devices, and wiring. Expansion shall not require operator interface hardware additions or software revisions.

### 3.3 Operator Interface

- A. Operator Interface. Web server shall reside on the Owner's network.
- B. Communication. Web server, workstations, portable terminals and controllers shall communicate using BACnet protocol. Web server, workstation, portable terminal and control network backbone shall communicate using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing as specified in ASHRAE/ANSI 135-2001, BACnet Annex J.
- C. Hardware. Any Web server upgrades, workstations and portable terminals shall be approved by the Owner's Technology Division. Hardware to be provided for this project shall consist of the following:
  - 1. Web server upgrades shall be provided as required to meet or exceed DDC system manufacturer's recommended specifications with the addition of this project to the web server. Hard disk shall have sufficient memory to store system software, one year of data for trended points and for a growth in system database at least equal to this project's database at system acceptance. Configure computers and network connections if multiple computers are required to meet specified memory and performance.

2. Workstation shall be provided to consist of a color monitor and an IBM-compatible personal computer. The latest manufacturer approved platform at the time of EMCS installation. The display provided for system operation shall have a diagonal screen measurement of no less than 19" and a minimum display resolution of no less than 1280 X 1024 pixels non-interlaced. Separate controls shall be provided for color, contrasts and brightness. The screen shall be non-reflective. Install all EMCS operating and maintenance manuals and documentation in electronic PDF format on the hard disk.
  3. Portable Operator's Terminal shall be provided to consist of an IBM-compatible laptop computer for use as a Portable Operator's Terminal. The latest manufacturer approved platform at the time of EMCS installation. Operator shall be able to connect to the system network as a workstation or directly to each controller for programming, set up, and troubleshooting (any proprietary software or hardware key that may be required for direct connection shall be provided). Terminal shall be made available for use by Test and Balance personnel and the Commissioning Authority before being turned over to DCPS Maintenance.
- D. Operator Functions. : All operator functions shall be accessible from any browser on the network that has access to the Web server without requiring any additional software. Operator interface shall allow each authorized operator to execute the following functions as a minimum:
1. Log In and Log Out. System shall require user name and password to log in to operator interface.
  2. Point-and-click Navigation. Operator interface shall be graphically based and shall allow operators to access graphics for equipment and geographic areas using point-and-click navigation.
  3. View and Adjust Equipment Properties. Operators shall be able to view controlled equipment status and to adjust operating parameters such as setpoints, PID gains, on and off controls, and sensor calibration.
  4. View and Adjust Operating Schedules. Operators shall be able to view scheduled operating hours of each schedulable piece of equipment on a weekly or monthly calendar-based graphical schedule display, to select and adjust each schedule and time period, and to simultaneously schedule related equipment. EMCS shall clearly show exception schedules and holidays on the schedule display.
  5. View and Respond to Alarms. Operators shall be able to view a list of currently active system alarms, to acknowledge each alarm, and to clear (delete) unneeded alarms.
  6. View and Configure Trends. Operators shall be able to view a trend graph of each trended point and to edit graph configuration to display a specific time period, add or delete points or data range. Operator shall be able to create custom trend graphs to display on the same page data from multiple trended points. All system software and hardware points shall be able to be trended.

7. View and Configure Reports. Operators shall be able to run preconfigured reports, to view report results, and to customize report configuration to show data of interest.
  8. Manage Control System Hardware. Operators shall be able to view controller status, to restart (reboot) each controller, and to download new control software to each controller.
  9. Manage Operator Access. Typically, only a few operators are authorized to manage operator access. Authorized operators shall be able to view a list of operators with system access and of functions they can perform while logged in. Operators shall be able to add operators, to delete operators, assign specific sites and to edit operator function authorization. Operator shall be able to authorize each operator function separately.
- E. System Software.
1. Operating System. Web server or workstation shall have an industry-standard professional-grade operating system. Acceptable systems include Microsoft Windows 2000 Pro and Windows XP.
  2. System Graphics. Operator interface shall be graphically based and shall include (1) at least one graphic per piece of equipment (AHUs, FCUs, FTUs, VAVs, etc.) with a controller, (2) graphics for each chilled water and hot water system, (3) floor plan graphics that indicate thermal zoning and the thermal comfort using dynamic colors to represent zone temperature relative to set point, (4) equipment summary graphics listing all AHUs, FCUs, FTUs, VAVs, etc. and beside each the thermal comfort using dynamic colors to represent zone temperature relative to set point (VAV AHUs with multiple zones shall have their cooling coil discharge temperature compared to discharge setpoint). The graphic for each piece of equipment with a controller shall be easily selected from either the floor plan graphic or the equipment summary graphic. All set points, schedules, overrides, etc. associated with a piece of equipment shall be easily accessed and changed from its associated graphic. In addition, the sequence of operation and the logic diagram for each piece of equipment shall be easily selected from the equipment graphic.
  3. Functionality. Graphics shall allow operator to monitor system status, to view a summary of the most important data for each controlled zone or piece of equipment, to use point-and-click navigation between zones or equipment, and to edit setpoints and other specified parameters.
    - a. Animation. Graphics shall be able to animate by displaying different image files for changed object status.
    - b. Alarm Indication. Indicate areas or equipment in an alarm condition using color or other visual indicator.

- c. Format. Graphics shall be saved in an industry-standard format such as BMP, JPEG, or GIF. Web-based system graphics shall be viewable on browsers compatible with World Wide Web Consortium browser standards. Web graphic format shall not require widely available plug-ins (such as Active-X and Macromedia Flash).
- F. System Tools. System shall provide the following functionality to authorized operators as an integral part of the operator interface or as stand-alone software programs. If furnished as part of the interface, the tool shall be available from each workstation or web browser interface. If furnished as a stand-alone program, software shall be installable on standard IBM-compatible PCs with no limit on the number of copies that can be installed under the system license.
  1. Automatic System Database Configuration. Each workstation or web server shall store on its hard disk a copy of the current system database, including controller firmware and software. Stored database shall be automatically updated with each system configuration or controller firmware or software change.
  2. Controller Memory Download. Operators shall be able to download memory from the system database to each controller.
  3. System Configuration. Operators shall be able to configure the system.
  4. Online Help. Context-sensitive online help for each tool shall assist operators in operating and editing the system.
  5. Security. System shall require a user name and password to view, edit, add, or delete data.
    - a. Operator Access. Each user name and password combination shall define accessible viewing, specific site, editing, adding, and deleting functions in each system application, editor, and object.
    - b. Automatic Log Out. Automatically log out each operator if no keyboard or mouse activity is detected. Operators shall be able to adjust automatic log out delay.
    - c. Encrypted Security Data. Store system security data including operator passwords in an encrypted format. System shall not display operator passwords.
  6. System Diagnostics. System shall automatically monitor controller and I/O point operation. System shall annunciate controller failure and I/O point locking (manual overriding to a fixed value).

7. Alarm Processing. System input and status objects shall be configurable to alarm on departing from and on returning to normal state. Operator shall be able to enable or disable each alarm and to configure alarm limits, alarm limit differentials, alarm states, and alarm reactions for each system object. Configure and enable alarm points as specified in Sequence of Operations or on drawings. Alarms shall be BACnet alarm objects and shall use BACnet alarm services.
8. Alarm Messages. Alarm messages shall use an English language descriptor without acronyms or mnemonics to describe alarm source, location, and nature.
9. Alarm Reactions. Operator shall be able to configure (by object) actions workstation or web server shall initiate on receipt of each alarm. As a minimum, workstation or web server shall be able to log, print, start programs, display messages, send e-mail, send page, and audibly annunciate.
10. Alarm Maintenance. Operators shall be able to view system alarms and changes of state chronologically, to acknowledge and delete alarms, and to archive closed alarms to the workstation or web server hard disk from each workstation or web browser interface.
11. Trend Configuration. Operator shall be able to configure trend sample or change of value (COV) interval, start time, and stop time for each system data object and shall be able to retrieve data for use in spreadsheets and standard database programs. Controller shall sample and store trend data and shall be able to archive data to the hard disk. Configure trends as Sequences of Operation and point schedules on drawings. Trends shall be BACnet trend objects.
12. Object and Property Status and Control. Operator shall be able to view, and to edit if applicable, the status of each system object and property by menu, on graphics, or through custom programs.
13. Reports and Logs. Operator shall be able to select, to modify, to create, and to print reports and logs. Operator shall be able to store report data in a format accessible by standard spreadsheet and word processing programs.
14. Standard Reports. Furnish the following standard system reports:
  - a. Objects. System objects and current values filtered by object type, by status (in alarm, locked, normal), by equipment, by geographic location, or by combination of filter criteria.
  - b. Alarm Summary. Current alarms and closed alarms. System shall retain closed alarms for an adjustable period.
  - c. Logs. System shall log the following to a database or text file and shall retain data for an adjustable period:
    1. Alarm History.
    2. Trend Data. Operator shall be able to select trends to be logged.

3. Operator Activity. At a minimum, system shall log operator log in and log out, control parameter changes, schedule changes, and alarm acknowledgment and deletion. System shall date and time stamp logged activity.
15. Custom Reports. Operator shall be able to create custom reports that retrieve data, including archived trend data, from the system, that analyze data using common algebraic calculations, and that present results in tabular or graphical format. Reports shall be launched from the operator interface.
16. Graphics Generation. Graphically based tools and documentation shall allow Operator to edit system graphics, to create graphics, and to integrate graphics into the system. Operator shall be able to add analog and binary values, dynamic text, static text, and animation files to a background graphic using a mouse.
17. Floor plan graphics for a building or air handler zone shall show exterior and interior walls, F.I.S.H. space numbers, indicate the boundaries of all heating and cooling zones throughout the building, and provide a visual display of actual space temperatures and their respective setpoints. Locations of space sensors shall be shown for each zone. A range of colors shall provide a visual and dynamic (auto-updated) display of temperatures relative to setpoints. Floor plan graphics shall indicate the locations of major equipment such as central air handling units and a central plant with descriptors (AH-3 for example). From the floor plan graphic, an operator shall be able to easily bring up mechanical system graphics of monitored and controlled components (variable air volume terminals, air handling units or the central plant for example), which serve the areas depicted on the floor plan graphic.
18. The EMCS Contractor will be provided AutoCAD floor plan files for all new installations that have been developed by the EDP or Owner. However, these Auto-Cad files must be "cleaned up" to make them suitable for EMCS system application. Alternatively, floor plan blueprints may be provided to the EMCS Contractor for use in developing floor plan graphics.
19. Graphics Library. Complete library of standard HVAC equipment graphics shall include equipment such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators. Library shall include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. Library graphic file format shall be compatible with graphics generation tools.
20. Custom Application Programming. Operator shall be able to create, edit, debug, and download custom programs. System shall be fully operable while custom programs are edited, compiled, and downloaded. Programming language shall have the following features:
  - a. Language. Language shall be graphically based logic diagrams. Language shall use function blocks arranged in a logic diagram that clearly shows control logic flow. Function blocks shall directly provide functions listed below, and operators shall be able to create custom or compound function blocks.

- b. Programming Environment. Tool shall provide a full-screen, cursor-and-mouse-driven programming environment that incorporates word processing features such as cut and paste. Operators shall be able to insert, add, modify, and delete custom programming code, and to copy blocks of code to a file library for reuse in other control programs.
- c. Independent Program Modules. Operator shall be able to develop independently executing program modules that can disable, enable and exchange data with other program modules.
- d. Debugging and Simulation. Operator shall be able to configure application software offline for custom software development such as system reports, data collection routines, custom alarm management software, etc. Operator shall be able to step through the program observing intermediate values and results. Operator shall be able to adjust input variables to simulate actual operating conditions. Operator shall be able to adjust each step's time increment to observe operation of delays, integrators, and other time-sensitive control logic. Debugger shall provide error messages for syntax and for execution errors.
- e. Conditional Statements. Operator shall be able to program conditional logic using compound Boolean (AND, OR, and NOT) and relational (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.
- f. Mathematical Functions. Language shall support floating-point addition, subtraction, multiplication, division, and square root operations, as well as absolute value calculation and programmatic selection of minimum and maximum values from a list of values.
- g. Variables: Operator shall be able to use variable values in program conditional statements and mathematical functions.
  - 1. Time Variables. Operator shall be able to use predefined variables to represent time of day, day of the week, month of the year, and date. Other predefined variables or simple control logic shall provide elapsed time in seconds, minutes, hours, and days. Operator shall be able to start, stop, and reset elapsed time variables using the program language.
  - 2. System Variables. Operator shall be able to use predefined variables to represent status and results of Controller Software and shall be able to enable, disable, and change setpoints of Controller Software as described in Controller Software section.
- h. Program shall provide psychrometric functions for calculation of properties of air such as wetbulb and dewpoint.

### 3.4 Controller Software

- A. Building and energy management application software shall reside and operate in system controllers. Applications shall be editable through operator workstation, web browser interface, or engineering workstation.
- B. Scheduling. System shall provide the following schedule options as a minimum:
  - 1. Weekly. Provide separate schedules for each day of the week. Each schedule shall be able to include up to 5 occupied periods (5 start-stop pairs or 10 events).
  - 2. Exception. Operator shall be able to designate an exception schedule for each of the next 365 days. After an exception schedule has executed, system shall discard and replace exception schedule with standard schedule for that day of the week.
  - 3. Holiday. Operator shall be able to define 24 special or holiday schedules of varying length on a scheduling calendar that repeats each year.
  - 4. Zones. Set up the EMCS zones in cooperation with the Owner to facilitate energy efficient scheduling and override capabilities.
- C. System Coordination. Operator shall be able to group related equipment based on function and location and to use these groups for scheduling and other applications.
- D. Remote Communication. System shall automatically contact operator workstation or server on receipt of critical alarms.
- E. Energy Monitoring. EMCS shall monitor building power consumption if electric power (KW) transducer(s) are specified elsewhere. EMCS Contractor shall set up graphics required for the Owner to view current and historical daily load profiles. Where electric power (KW) transducer(s) are specified, a minimum of 365 days of data shall be stored. Data stored shall include the average KW demand over a maximum 15 minute period and the KWH energy consumption every 24 hours. Graphics shall be provided on the first page accessed through the web server that includes (1) an electric meter graphic with the current KW power level, (2) a graph of the past 3days (72 hours) of KW data (a portion of the 3 days may be selected and expanded) and (3) a graph of the most recent 16 weeks of energy consumption per square foot (square feet from DCPS FISH data shall be an owner input) on an annualized basis (multiply 7 day (1 week) consumption by 52 weeks to annualize).
- F. Sequencing. EMCS shall sequence chillers, boilers, and pumps as specified in Sequences of Operation.
- G. PID Control. System shall provide direct- and reverse-acting PID (proportional-integral-derivative) algorithms. Each algorithm shall have anti-windup and selectable controlled variable, setpoint, and PID gains. Each algorithm shall calculate a time-varying analog value that can be used to position an output or to stage a series of outputs.
- H. Staggered Start. System shall stagger controlled equipment restart after power outage. Operator shall be able to adjust equipment restart order and time delay between equipment restarts.
- I. Energy Calculations.

1. System shall accumulate and convert instantaneous power (kW) or flow rates (L/s [gpm]) to energy usage data.
  2. System shall calculate a sliding-window average (rolling average). Operator shall be able to adjust window interval to 15 minutes, 30 minutes, or 60 minutes.
  3. System shall calculate a fixed-window average. Window interval start shall be defined by utility meter digital input signal to synchronize system's and utility's fixed-window averages.
- J. Anti-Short Cycling. Binary output objects shall be protected from short cycling by means of adjustable minimum on-time and off-time settings.
- K. On and Off Control with Differential. System shall provide direct- and reverse-acting on and off algorithms with adjustable differential to cycle a binary output based on a controlled variable and setpoint.
- L. Runtime Totalization. System shall provide an algorithm that can totalize runtime for each binary input and output. Operator shall be able to enable runtime alarm based on exceeded adjustable runtime limit. Configure and enable runtime totalization and alarms as specified in Sequence of Operations.
- M. Optimized Start / Stop. System shall provide a learning algorithm which will allow the system to start at the latest possible time to bring each space to design conditions at the scheduled occupancy time, and stop at the earliest possible time to keep the space at design conditions just until the end of the scheduled occupancy time.
- ~~M.N.~~ Night Setback / Setup. System shall allow for unoccupied heating and cooling setpoints to keep the space under control but at a more cost effective state.
- ~~N.O.~~ Heating and Cooling Setpoints. System shall allow for separate heating and cooling setpoints. This will allow for a deadband between the two stages where neither heating nor cooling is being used (no cost) and it also prevents the system from chattering back and forth between heating and cooling on either side of a single setpoint.
- ~~Ø.P.~~ Low Ventilation Mode. In this mode, no outside air needs to be introduced into the building so only re-circulated air needs to be treated to maintain the nighttime setpoints. Outdoor air is closed off and all exhaust fans are off.
- Q. CO<sub>2</sub> Control. When specified, EMCS shall be able to use actual CO<sub>2</sub> measurements and control algorithms to adjust the amount of outside air being introduced into the space, instead of always bringing in the design (full capacity) CFM requirements.

### 3.5 Controllers

- A. BACnet.

1. Building Controllers (BCs). Each BC shall have demonstrated interoperability during at least one BMA Interoperability Workshop and shall substantially conform to BACnet Building Controller (B-BC) device profile as specified in ASHRAE/ANSI 135-2001, BACnet Annex L.
  2. Advanced Application Controllers (AACs). Each AAC shall have demonstrated interoperability during at least one BMA Interoperability Workshop and shall substantially conform to BACnet Advanced Application Controller (B-AAC) device profile as specified in ASHRAE/ANSI 135-2001, BACnet Annex L.
  3. Application Specific Controllers (ASCs). Each ASC shall conform to BACnet Application Specific Controller (B-ASC) device profile as specified in ASHRAE/ANSI 135-2001, BACnet Annex L and shall be listed as a certified B-ASC in the BACnet Testing Laboratories (BTL) Product Listing.
  4. BACnet Communication.
    - a. Each BC shall reside on or be connected to a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing.
    - b. BACnet routing shall be performed by BCs or other BACnet device routers as necessary to connect BCs to networks of AACs and ASCs.
    - c. Each AAC and ASC shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
    - d. Each SA shall reside on a BACnet network using the MS/TP Data Link/Physical layer protocol.
- B. Communication.
1. Service Port. Each controller shall provide a service communication port for connection to a Portable Operator's Terminal. Connection shall be extended to space temperature sensor ports where shown on drawings.
  2. Signal Management. BC and ASC operating systems shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and to allow for central monitoring and alarms.
  3. Data Sharing. Each BC and AAC shall share data as required with each networked BC and AAC.
  4. The system shall be capable of stand-alone operation in the event of communication failure. All I/O points specified for a piece of equipment shall be integral to its controller. Provide stable and reliable stand-alone control using default values or other method for values normally read over the network.
- C. Environment. Controller hardware shall be suitable for anticipated ambient conditions.

1. Controllers used outdoors or in wet ambient conditions shall be mounted in waterproof enclosures and shall be rated for operation at -29°C to 60°C (-20°F to 140°F).
  2. Controllers used in conditioned space shall be mounted in dust-protective enclosures and shall be rated for operation at 0°C to 50°C (32°F to 120°F).
- D. Local Controller Interface. Provide the software and any interface cabling needed to use a laptop computer as a Portable Operator's Terminal for the system.

### 3.6 DEVICES:

- A. Temperature sensors.
1. Temperature sensors shall be Resistance temperature Device (RTD) or thermistor.
  2. Duct sensors shall be single point or averaging as shown. Veris Industries, Automation Components Inc., Building Automation Products Inc. or pre-approved equal.
  3. Immersion sensors shall be provided with a separable stainless steel well. Pressure rating of well is to be consistent with the system pressure in which it is to be installed. Veris Industries, Automation Components Inc., Building Automation Products Inc. or pre-approved equal.
  4. All space sensors shall be equipped with override switch and communication port. Space sensors located in supervised spaces such as classrooms and office areas shall be provided with a space set point adjustment and be a standard product of the EMCS manufacturer. Space sensors located in non-supervised common areas such as corridors, gymnasium, cafeteria, auditorium, locker rooms, etc. shall be stainless steel Wall Plate Units. At least one stainless steel Wall Plate Unit shall be located in all non-supervised common areas except corridors that is equipped with a Durable model pushbutton override with an "AC Override" durable and permanent label. Stainless steel Wall Plate Units shall be Building Automation Products, Inc. or pre-approved equal.
  5. Provide matched temperature sensors for differential temperature measurement.
- B. Relative Humidity Transmitters: Relative Humidity Transmitters shall use bulk polymer resistance technology for sensing. Transmitters shall be accurate within 5% and shall have true 4 to 20 mA analog output directly proportional to relative humidity. Provide case and associated hardware for space, duct, outside, or remote mounting as appropriate. Transmitters shall be General Eastern, Veris Industries, Automation Components Inc. or pre-approved equal.
1. Room Humidity Sensors. Provide surface mount device for mounting on standard electrical switch box. Cover shall match room temperature element.
  2. Duct Humidity Sensors. Provide units with integral conduit mounting box and shield to protect element from damage.

- C. Low Temperature Protection Thermostats: Provide low temperature protection thermostats of automatic or manual-reset type as required by the sequence of operations, with sensing elements 8' or 20' in length. Provide thermostat designed to operate in response to coldest 1'-0" length of sensing element, regardless of temperature at other parts of element.
1. Support element properly to cover the entire duct width.
  2. Provide separate thermostats for each 25 square feet of coil face area or fraction thereof.
  3. Install sensor per manufacturers published recommendations.
- D. Flow Status Switches: Fan and pump flow status shall be monitored through motor current status switches in lieu of differential pressure switches. Current status switches shall have an adjustable setpoint and be capable of detecting belt/drive loss and motor failure. Switches shall be Veris Industries or pre-approved equal model Hawkeye 705, 907 or 908 with LED status except that variable volume applications must be model Hawkeye 907 (automatically compensates for variable volume effects, including VFD's).
- E. Differential Pressure Transducers: Differential pressure transducers shall be as required with internal signal conditioning and true analog output. The devices shall be Modus, Inc. or Veris Industries (air) and Robinson Halpern, Veris Industries or Auto Tran (water) or pre-approved equal. Provide pressure snubbers and isolation valves for water differential pressure applications to prevent damage due to pressure shocks and facilitate service and calibration.
- F. Flow Measuring Devices:

[Engineering Note: The following should be modified according to the specific project requirements and be coordinated with the references on the drawings. In particular, please note the "Where specifically allowed by the EDP" references below.]

1. Air Flow:
  - a. Air flow stations consisting of pre-engineered sensor probe assemblies with a single microprocessor-based transmitter. Each sensor probe assembly will contain one or more independently wired sensor housings. Multiple sensor housings shall be equally weighted and averaged by the transmitter prior to output. Each sensor housing shall utilize two hermetically sealed, bead-in-glass thermistor probes to determine airflow rate and ambient temperature. Each sensor housing shall be calibrated at a minimum of 16 airflow rates and have an accuracy of +/-2% of reading over the entire operating airflow range. Probe assembly mounting brackets shall be constructed of 304 stainless steel. The transmitter shall be capable of communicating with the host controls using either a linear analog output signal or RS-485. The number of sensor housings provided and their placement shall be determined by the manufacturer's authorized representative for each measurement location indicated on the plans. Assemblies shall be Ebtron "Silver" series or pre-approved equal.



- J. Relays: Relay contacts shall be rated for the application, with Form C contacts, enclosed in a dust-proof enclosure. Relays shall have contacts with a minimum life span rating of one million operations. Relays shall be equipped with coil transient suppression. Provide additional relays as necessary to carry the intended load where load requirements exceed the 0.5 amp rating of EMCS Hardware Units. Open relays shall be IDEC with led indicator, and relays in an enclosure shall be Functional Devices, RIB series or pre-approved equal.
- K. Contactors: Contactors shall be of the single coil, electrically operated, and electrically held type. Contacts shall be double break silver-to-silver type protected from arcing contacts. Number of contacts and ratings shall be selected for application. Operating and release times shall be 100 milliseconds or less. Contactors shall be equipped with coil transient suppression devices. Provide as necessary to carry the intended load where load requirements exceed the 0.5 amp rating of EMCS Hardware Units. Use Furnas or pre-approved equal.
- L. POWER SUPPLIES AND LINE FILTERING
1. Control power supplies and transformers shall be as required by the voltage and/or application and loaded no more than 80% rated capacity. Provide a resettable circuit breaker at the secondary side of each transformer. Each power supply or transformer shall be UL approved class 2 unit with an operating ambient temperature range from -40 Deg. F. to 120 Deg. F. and a humidity level from 10% to 90% noncondensing.
    - a. DC power supply output shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak to peak. Regulation shall be 1% line and load combined, with 100 micro-second response time for 50% load changes. Unit shall have built-in over-voltage and over-current protection and shall be able to withstand 150% current overload for at least three seconds without trip-out or failure.
    - b. Power line filtering shall be provided as required and shall include internal or external transient voltage and surge suppression for all controllers. All failures due to transient voltages and surges shall be a warranty item. Surge protection shall have (1) dielectric strength of 1,000 V minimum, (2) response time of 10 nanoseconds or less, (3) transverse mode noise attenuation of 65 db or greater and (4) common mode noise attenuation of 150 db or greater at 40-100 HZ.
- M. DAMPERS:
1. Provide automatic control dampers as indicated, with damper frames not less than formed 16-ga galvanized steel. Provide damper blades not less than formed 16-ga galvanized steel, with maximum blade width of 8".

- a. Secure blades to 1/2" diameter plated steel axles using zinc-plated hardware. Seal off against spring stainless steel blade bearings. Provide blade bearings of nylon and provide thrust bearings at each end of every blade.
  - b. Parallel blade operation shall be used for all two position applications and opposed blade configurations for all modulating applications.
  - c. Performance Data
    1. Capacity: Demonstrate capacity of damper to withstand HVAC system operating conditions.
      - a. Closed Position: Maximum pressure of 5 inches w.g. @ a 12 inch blade length.
      - b. Open Position: Maximum air velocity of 2,000 feet per minute.
      - c. Leakage: Maximum 3.7 cubic feet per minute per square foot at 1 inch w.g. for all sizes 36 inches wide and above.
    2. Pressure Drop: Maximum 0.07 inch w.g. at 1,500 feet per minute across 24 inch x 24 inch damper.
- N. Chilled and Hot Water Control Valves:
1. Ball valves shall be used for all water applications where sizing permits. Valves may not be smaller than 1/2 line size. Pressure drop to be 3-5 PSI.
  2. Valves 1/2" through 3" shall be forged brass body with nickel plating, NPT screw type. The operating range shall be 0°F to 212° F. control valves shall be furnished with a stainless steel ball & stem and fiberglass reinforced Teflon seats and seals.
  3. The valves shall have an ISO type 4-bolt flange for mounting actuator in any orientation parallel or perpendicular to the pipe. A non-metallic thermal isolation adaptor shall separate the flange from the actuator with high temperature materials rated for continual use at greater than the application temperature. Valve assemblies without thermal isolation as described are not acceptable.
  4. The isolation adaptor shall also provide stable direct coupled mechanical connection between the valve body and actuator and prevent lateral or rotational forces from affecting the stem and its packing O-rings.
  5. All control valves shall have a TEFZEL flow-characterizing disc in the inlet of 2-way characterized control valves and in the control port of 3-way valves. Three-way valves shall be applicable for both mixing and diverting.

6. Control valves shall be two-way or three-way type for two-position or modulating service as shown. Valve CV shall be selected for a 3 to 5 psi pressure drop. Air handling unit water valves shall be sized for a pressure drop equal to the coil they serve, but not to exceed 5 psi.
7. The EMCS Contractor shall furnish all the control valves of the type indicated on the drawings for installation by others.
8. Electronic control valve actuators shall be as manufactured, brand labeled, or distributed by Belimo or pre-approved equal.

O. BUTTERFLY VALVES

1. Butterfly valves and/or actuators shall be as manufactured, brand labeled, or distributed by Belimo, or pre-approved equal.
2. Butterfly valves 2" to 30" shall have a fully lugged, drilled and tapped cast iron body. Flanges shall meet ANSI 150 standards. The one-piece body shall feature an extended neck allowing sufficient clearance for flanges and 2" of piping insulation. The disc shall be 304 stainless steel and provide bubble-tight close off for water or 50% glycol applications.
3. The 2" through 6" valves shall be rated for a maximum of 50-psi close off using standard Belimo actuators. Valves 2" through 12" shall be available in 50 or 200 pound close off as required by the application. Valves 14" through 30" shall be rated at 150 psi close off.
4. Actuators shall be applied according to the manufacturer's specifications.

## P. DAMPER AND VALVE ACTUATORS

1. Actuators shall be fully modulating/proportional, tri-state, or two position as required and be factory or field selectable. Actuators shall provide a selectable feedback voltage and have visual position indications. Actuators shall operate in sequence with other devices if required.
2. Actuators shall be available to operate on 24 or 120 VAC, or 24 VDC and Class 2 wiring as dictated by the application. Power consumption shall not exceed 10 VA for AC, including 120 VAC actuators, and 8 watts for DC applications.
3. Actuators shall have electronic overload protection or digital rotation sensing circuitry to prevent actuator damage throughout the entire rotation. End switches to deactivate the actuator at the end of rotation or magnetic clutches are not acceptable.
4. EMCS Contractor shall provide a two year unconditional warranty from date of installation. EMCS Contractor shall provide an additional three year conditional warranty for a total warranty period of five years from the date of installation.
5. Each valve shall fail open or closed to the coil as indicated in the sequence of operation.
6. The valve actuator shall be capable of providing the minimum torque required for proper valve close off to exceed the dead head pressure of the largest pump within the system, or 60 psi, which ever is greater.
7. Electronic control damper actuators shall be as manufactured, brand labeled, or distributed by Belimo or pre-approved equal.
8. Damper Actuator installation shall be connected directly to the damper shaft in a completely perpendicular position to the damper shaft with a mount that is robust and will secure in two spots that are far enough apart to prevent the mounts from being broken after repeated use.

Q. Environmental Conditions: All equipment shall operate under ambient environmental conditions of 35 degrees to 122 degrees F dry bulb and 10 to 95 percent RH noncondensing. Sensors and control elements shall operate under the ambient environmental temperature, pressure, humidity, and vibration conditions specified or normally encountered for the installed location.

R. System Accuracy: The system shall maintain an end-to-end accuracy, as listed for the applications specified.

<b>Table 1 - Reporting Accuracy</b>	
Measured Variable	Reported Accuracy
Space Temperature	±0.5°F
Ducted Air	±0.5°F
Outside Air	±0.5°F
Dew Point	±1°F
Water Temperature	±0.5°F
Delta-T	±0.5°F
Relative Humidity	±5% RH
Water Flow	±2% of full scale
Airflow (terminal)	±10% of full scale (see Note 1)
Airflow (measuring stations)	±5% of full scale
Airflow (pressurized spaces)	±3% of full scale
Air Pressure (ducts)	±0.1 in. w.g.
Air Pressure (space)	±0.02 in. w.g.
Water Pressure	±2% of full scale (see Note 2)
Electrical (A, V, W, Power Factor)	5% of reading (see Note 3)
Carbon Monoxide (CO)	±5% of reading
Carbon Dioxide (CO2)	±50 ppm
Note 1: 10%-100% of scale	
Note 2: For both absolute and differential pressure	
Note 3: Not including utility-supplied meters	

<b>Table 2 - Control Stability and Accuracy</b>		
Controlled Variable	Control Accuracy	Range of Medium
Air Pressure	±0.2 in. w.g.	0-6 in. w.g.
Airflow	±10% of full scale	
Space Temperature	±1.0°F	
Duct Temperature	±1.5°F	
Humidity	±5% RH	
Fluid Pressure	±1.5 psi	1-150 psi

## 3.7 WIRE, CABLE, CONDUIT AND POWER SUPPLIES:

- A. Conduit: Provide conduit for all wire and cable in accordance with Division 16. The EMCS Contractor shall take particular care to ensure that conduit run underground is properly sealed to prevent water intrusion.
- B. Cable used in various locations and applications shall be as recommended by the EMCS manufacturer.
- C. Wiring shall be continuous with no joints except at equipment terminations. Drain wire shall be continuous and grounded at one end only, as per manufactures recommendations.
- D. Transmitter Wiring: Transmitter wiring, or other 4-20 ma. signaling device wiring shall be continuous from the device to its Controller Unit. Drain wire shall be continuous and grounded at the Controller Unit only. Transmitter wiring shall be Belden, West Penn 303 or pre-approved equal.
- E. Power Supplies: The EMCS Contractor shall be responsible for providing all power supplies required, including control transformers, and any connections to building electrical system which are required and are not explicitly shown on the electrical drawings. Power supplies system to have properly sized and installed grounding and a surge suppression system to adequately protect EMCS equipment.
- F. Underground wiring to be rated for underground use and approved by Owner.  
Underground cable to be inspected by Owner before termination of devices.

## PART 4 - EXECUTION:

## 4.1 GENERAL. THE EMCS CONTRACTOR SHALL BE RESPONSIBLE FOR:

- A. Installing all system components in accordance with the manufacturer's recommendations.
- B. Providing all input and control devices and necessary interconnections of wire, cable and conduit.
- C. System startup, commissioning and adjustments required for a complete operable system. EMCS Contractor shall coordinate with the EDP, Mechanical Contractor and GC/CM to ensure the system operates as specified.
- D. Provide operations and maintenance manuals covering the entire EMCS.

## 4.2 INSTALLATION. THE EMCS CONTRACTOR SHALL BE RESPONSIBLE FOR:

- A. General. Install system and materials in accordance with manufacturer's instructions and roughing-in drawings, and details on drawings. Mount controllers at convenient locations and heights.
- B. EMCS installation shall be performed by the EMCS Contractor. Coordinate installation with all other affected trades. Provide necessary project management personnel.

## 4.3 ELECTRICAL INSTALLATION. THE EMCS CONTRACTOR SHALL BE RESPONSIBLE FOR:

- A. Coordination of the EMCS design with the EDP.
- B. Providing shop drawings and a complete list of all EMCS hardware including input and control devices required for the project with the source of supply clearly indicated.
- C. The EMCS Contractor shall be responsible for providing all wire, cable, and conduit required by this section. All wiring and cable shall be approved for its intended use and shall be run in conduit where exposed. All wire, cable and conduit shall be installed to conform with Division 16 requirements and the National Electrical Code, NFPA 70. Wiring may be run without conduit in concealed locations where wire will not be damaged. Plenum rated wire must be used in plenums.
- D. Wire shall be labeled at the control panel. Labels shall be Brady PWM Series or pre-approved equal, and shall be marked in accordance with descriptors or abbreviations used on the control drawings.
- E. All wiring, conduit and devices pertaining to the fire alarm system shall be provided under Division 16.

- F. EMCS Contractor shall provide all external control wiring and conduit to starters and internal wiring in starters as required for start/stop control. Final installation of the starter and the provision of all power wiring, conduit and terminations shall be accomplished under Division 16.
- G. Providing operation and maintenance manuals covering equipment and software provided and providing framed control drawings.

4.4 INSTALLATION OF SENSORS. THE EMCS CONTRACTOR SHALL BE RESPONSIBLE FOR:

- A. Install sensors in accordance with the manufacturer's recommendations.
- B. Mount sensors rigidly and adequately for the environment within which the sensor operates.
- C. Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing.
- D. Relocate space thermostats/sensors if required due to draft, interference with cabinets, chalkboards, etc., or improper sensing.
- E. All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.
- F. Sensors used in mixing plenums and hot and cold decks shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner vertically across the duct. Each bend shall be supported with a capillary clip.
- G. Low-limit sensors used in mixing plenums shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip. Provide 3 m of sensing element for each 1 m<sup>2</sup> (1 ft of sensing element for each 1 ft<sup>2</sup>) of coil area.
- H. All pipe-mounted temperature sensors shall be installed in wells. Install all liquid temperature sensors with heat-conducting fluid in thermal wells.
- I. Install outdoor air temperature sensors on north wall, complete with sun shield at designated location.

4.5 DIFFERENTIAL AIR STATIC PRESSURE. THE EMCS CONTRACTOR SHALL BE RESPONSIBLE FOR:

- A. Supply Duct Static Pressure: Pipe the high-pressure tap to the duct using a pitot tube. Make pressure tap connections in accordance with the manufacturers instructions.
- B. Building Static Pressure: Pipe the low-pressure port of the pressure sensor to the static pressure port located on the outside of the building through a high-volume accumulator. Pipe the high-pressure port to a location behind a thermostat cover.

- C. The piping to the pressure ports on all pressure transducers shall contain a capped test port located adjacent to the transducer.
- D. All pressure transducers, other than those controlling VAV boxes, shall be located in field device panels, not on the equipment monitored or on ductwork. Mount transducers in a vibration free location accessible for service without use of ladders or special equipment.
- E. All air and water differential pressure transducers shall have gauge tees mounted adjacent to the taps. Water gauges shall also have shutoff valves installed before the tee.
- F. Tubing for pressure sensors shall be rigid copper tubing for water and plastic in conduit for air with bend radii large enough so as not to impede accurate sensor readings.

4.6 CONTROL WIRING. THE EMCS CONTRACTOR SHALL BE RESPONSIBLE FOR:

- A. Provide all electrical work required as an integral part of the EMCS work. Install a complete wiring system for the EMCS including wire, conduit and miscellaneous materials as required for mounting and connecting control devices. Conceal wiring except in mechanical rooms and areas where other conduit and piping are exposed. All wiring to sensors and bus connections is low voltage and should be in accordance with local regulations and the National Electrical Code.
- B. Conduit: Provide conduit for all wire and cable in accordance with Division 16. The EMCS Contractor shall take particular care to ensure that conduit run underground is properly sealed to prevent water intrusion. Water intrusion will require conduit re-installation.
- C. The EMCS Contractor shall take particular care to provide shielded cable as required. Failure to do so will require replacement at the EMCS Contractor's expense.
- D. All wiring that is required to go underground must be rated for that use and approved. Underground wiring to be suitable for that use and approved by Owner. Underground cable to be inspected by Owner before termination of devices.
- E. Install equipment, piping, and wiring/raceway parallel to building lines (i.e., horizontal, vertical, and parallel to walls) wherever possible.
- F. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.
- G. All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.
- H. All EMCS and interlock wiring shall comply with national and local electrical codes and Division 16 of this specification. Where the requirements of this section differ from those in Division 16, the more stringent shall take precedence.
- I. All NEC Class 1 (line voltage) wiring shall be UL Listed in approved raceway according to NEC and Division 16 requirements.

- J. All low-voltage wiring shall meet NEC Class 2 requirements. (Low-voltage power circuits shall be subfused when required to meet Class 2 current limit.)
- K. Do not install Class 2 wiring in raceway containing Class 1 wiring. Boxes and panels containing high voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two (e.g., relays and transformers).
- L. Do not install wiring in raceway containing tubing.
- M. All wire-to-device connections shall be made at a terminal block or terminal strip. All wire-to-wire connections shall be at a terminal block.
- N. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.
- O. All wiring shall be installed as continuous lengths, with no splices permitted between termination points.
- P. Size of raceway and size and type of wire shall be the responsibility of the contractor, in keeping with the manufacturer's recommendations and NEC requirements, except as noted elsewhere.
- Q. Control and status relays are to be located in designated enclosures only. These enclosures include packaged equipment control panel enclosures unless they also contain Class 1 starters.
- R. Secure raceways with raceway clamps fastened to the structure and spaced according to code requirements. Raceways and pull boxes may not be hung on flexible duct strap or tie rods. Raceways may not be run on or attached to ductwork.
- S. Adhere to this specification's Division 16 requirements where raceway crosses building expansion joints.
- T. The EMCS Contractor shall terminate all control and/or interlock wiring related to the scope of work of this section and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.
- U. Flexible metal raceways and liquid-tight, flexible metal raceways shall not exceed 3 ft in length and shall be supported at each end. Flexible metal raceway less than ½ in. electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal raceways shall be used.
- V. Raceway must be rigidly installed, adequately supported, properly reamed at both ends, and left clean and free of obstructions. Raceway sections shall be joined with couplings (according to code). Terminations must be made with fittings at boxes, and ends not terminating in boxes shall have bushings installed.

4.7 WARNING LABELS. THE EMCS CONTRACTOR SHALL BE RESPONSIBLE FOR:

- A. Permanent warning labels shall be affixed to all equipment that can be automatically started by the EMCS.
- B. Labels shall use white lettering (12-point type or larger) on a red background.
- C. Warning labels shall read as follows:

**CAUTION**  
**This equipment is operating under automatic control and may start or stop at any time without warning. Switch disconnect to "Off" position before servicing.**

- D. Permanent warning labels shall be affixed to all motor starters and all control panels that are connected to multiple power sources utilizing separate disconnects.
- E. Labels shall use white lettering (12-point type or larger) on a red background.
- F. Warning labels shall read as follows:

**CAUTION**  
**This equipment is fed from more than one power source with separate disconnects. Disconnect all power sources before servicing.**

4.8 IDENTIFICATION OF HARDWARE AND WIRING. THE EMCS CONTRACTOR SHALL BE RESPONSIBLE FOR:

- A. All wiring and cabling, including that within factory fabricated panels, shall be labeled at each end within 2 in. of termination. Labels shall be Brady PWM Series or pre-approved equal, and shall be marked in accordance with descriptors or abbreviations used on the control drawings.
- B. All pneumatic tubing shall be labeled at each end within 2 in. of termination with a descriptive identifier.
- C. Permanently label or code each point of field terminal strips to show the instrument or item served.
- D. Identify control panels with minimum ½ in. letters on laminated plastic nameplates.
- E. Identify all other control components with permanent labels. All plug-in components shall be labeled such that removal of the component does not remove the label.

- F. Identify room sensors relating to terminal box or valves with nameplates.
- G. Manufacturers' nameplates and UL labels are to be visible and legible after equipment is installed.
- H. Identifiers shall match record documents.

4.9 SOFTWARE INSTALLATION. THE EMCS CONTRACTOR SHALL BE RESPONSIBLE FOR:

- A. General: Install all components and load all system software in accordance with manufacturer's recommendations.
- B. Load and debug all software required for an operational EMCS, including data base, operational parameters, and system and applications programs. Load and debug all control software necessary to implement all sequences of operation and as shown on the drawings.
- C. Set up system in accordance with Owner's energy conservation guidelines, including occupied/unoccupied and low ventilation schedules, optimal start/stop, setpoint limits, exhaust fan interlocks, etc.

## PART 5 - CONTROL SYSTEM CHECKOUT AND TESTING

[Engineering Note: If the project does not have an assigned Commissioning Authority, modify to reference Engineering Design Professional.]

- 5.1 The EMCS contractor shall be responsible for executing and documenting the following tasks. Completed documentation shall be submitted to **[Commissioning Authority (CA)] [Engineering Design Professional (EDP)]** for review and approval prior to commissioning.
- A. Check and test all systems for shorts, ground, continuity and finally for proper functioning and operation. A certified factory trained technician, employed by the EMCS Contractor, shall perform final connections of equipment, testing of the system and any other necessary adjustments.
  - B. After all EMCS work has been completed and put into operation, subject each system to an operating test under design conditions to insure proper sequence and operation throughout the range of operation. Make adjustments as required to insure proper functioning of all systems.
  - C. Provide personnel, tools and equipment and assist the Test and Balance Contractor in making any final adjustments, including air and water flow calibrations, etc. The EMCS Contractor is responsible to ensure all final Test and Balance numbers are inputted for each device.
  - D. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
  - E. Enable the control systems and verify calibration of all input devices individually. Perform calibration procedures according to manufacturers' recommendations.
  - F. Verify that all binary output devices (relays, solenoid valves, two-position actuators and control valves, magnetic starters, etc.) operate properly and that the normal positions are correct.
  - G. Verify that all analog output devices (I/Ps, actuators, etc.) are functional, that start and span are correct, and that direction and normal positions are correct.
    - 1. The EMCS Contractor shall check all control valves and automatic dampers to ensure proper action and closure.
    - 2. The EMCS Contractor shall make any necessary adjustments to valve stem and damper blade travel.
  - H. Verify that the system operation adheres to the specified sequences of operation including functionality, performance, setpoints and schedules.
    - 1. Simulate and observe all modes of operation by overriding and varying inputs, schedules, and setpoints.
    - 2. Tune all PID loops and any other control routines that require tuning.

- I. Verify that the correct equipment/ occupancy schedules have been inputted and applied to the proper equipment and systems for the appropriate building area function type. For example, offices, classrooms, media center, auditorium and/or gymnasium.
- J. Start-up Testing: All testing listed in this article shall be performed by the EMCS Contractor and shall make up part of the necessary verification of an operating EMCS. This testing shall be verified before the Owner or Owner's representative is notified for system demonstration.
- K. Submit documentation form templates and checkout plan for review and approval no more than 60 days after approved EMCS submittal. At a minimum, documentation shall be in a checklist format including the following columns and information:
  - 1. List of all devices to be inspected/ tested.
  - 2. Test/ inspection procedure/ requirement. (For example, device is calibrated, device opens and closes full span, device grounded, device function verified, etc)
  - 3. Pass/ Fail status
  - 4. Executing contractor personnel signature and date
- L. Checkout: Prior to requesting final acceptance of the system, demonstrate to the EDP as part of the commissioning process that all requirements of this Section have been fully satisfied.
- M. Furnish all labor and test apparatus required to calibrate and prepare for service of all instruments, controls, and accessory equipment furnished under this specification.

## PART 6 - CONTROL SYSTEM COMMISSIONING

### 6.1 COMMISSIONING:

#### [Engineering Notes:

Use the following paragraphs for projects **without** separate commissioning specifications such as sections 01810, 15995, 15997, 15998, etc. Otherwise use alternate text provided further below as noted.

If the project does not have an assigned Commissioning Authority, modify the following paragraphs to reference Engineering Design Professional (EDP).]

- A. Prior to acceptance, the [**Commissioning Authority (CA)**] [**Engineering Design Professional (EDP)**] shall subject the EMCS to a series of pre-functional and functional performance tests to verify operation and compliance with this specification. These tests shall occur after the EMCS Contractor has completed the installation, started up the system, and verified system operation as specified in Part 5 - CONTROL SYSTEM CHECKOUT AND TESTING above.

- B. The tests described in this section are to be performed in addition to the tests that the EMCS Contractor performs as a necessary part of the installation, start-up, and debugging process.
1. Pre-functional tests will be a sample based field verification of the checkout documentation submitted for review and approval by the EMCS contractor as specified PART 5 of this specification.
    - a. The [CA] [EDP] shall witness the EMCS contractor field verify up to [10%] [25%] [ XX%] of the devices.
    - b. Pre-functional tests will include verification tasks such as point-to-point, sensor calibration, and analog and digital output control.
  2. The [CA] [EDP] will be present to direct, observe and review 100% of the functional performance tests.
- C. The [CA] [EDP] shall be notified at least 10 days in advance of the readiness of the EMCS Contractor to perform the Functional Performance Tests via the submission of a Certificate of Readiness, signed and dated by the EMCS Contractor.
1. The Certificate of Readiness is a document, provided by the EMCS Contractor, which states the control system is 100% complete, including all hardware (sensors, actuators, power supplies, etc.), and software (programming, schedules, set up, graphics, etc.), all of the pre-functional testing is complete and that the functional performance tests provided by the [CA] [EDP] have been reviewed, and fully attempted, and all EMCS controlled equipment, sensors, devices and software algorithms are ready to officially undergo the functional performance testing phase of the commissioning process.
  2. Completed documentation required for checkout in PART 5 of this specification shall be submitted for review and approval along with Certificate of Readiness.
- D. The EMCS Contractor shall provide at least two persons equipped with two-way communication. Functional performance test requirements will include testing for all modes of operation including day, night, occupied, unoccupied, low ventilation, fire/smoke alarm, seasonal changeover, and power failure modes. The purpose is to demonstrate the response of each point and system in each mode of operation.
- E. The EMCS Contractor will demonstrate the complete operation of operator interfaces.
- F. The following items shall also be demonstrated:
1. P/PI/PID loop response. The EMCS Contractor shall supply trend data output in a graphical form showing the control loop step responses for each equipment and system type.
    - a. The quantity of equipment of each type to be tested shall be the greater of 10% of the total count of that equipment type or three (3). For equipment types with fewer than three (3), all equipment will be tested for loop response.

- b. The test shall show the loop's response to a change in set point, which represents a change of actuator position.
    - c. The sampling rate of the trend shall be from 5 seconds to 3 minutes, depending on the speed of the loop.
    - d. The trend data shall show for each sample the set point, actuator position, and controlled variable values.
    - e. Any loop that yields unreasonably under-damped or over damped control shall require further tuning by the EMCS Contractor.
  2. Interface to the building Fire Alarm System.
  3. Equipment/ occupancy schedules to verify equipment and systems operate only when required.
  4. Trend logs for each system that indicate set points, operating points, valve positions, and other data as specified in the Points List provided with each Sequence of Operation. These logs shall cover the most recent 48-hour period and have a sample frequency of not more than 10 minutes or as specified on the Points List. The logs shall be accessible in a graphical format through the system's user interface and retrievable for use in an Excel spreadsheet.
- G. Any tests that fail to demonstrate the operation of the system shall be repeated at a later date. The EMCS Contractor shall be responsible for any necessary repairs or revisions to the hardware or software to successfully complete all tests.
- H. EMCS contractor shall provide eight (8) non-consecutive hours of on-site technical support to be used as directed by the [CA] [EDP] for EDP approved deviations from the contract documents as it applies to the EMCS programming and interfaces. Associated material and equipment costs, if required, are NOT included.
  1. These hours shall be used but not limited to the following function types:
    - a. Programming changes to control specified algorithm/ sequence of operations
    - b. Changes to user interface that deviate from EDP specified layouts, graphics, functionality, points, or data
    - c. Adjustments to schedules or setpoints
    - d. Additional trended points
  2. These hours shall not be counted toward the EMCS contractor's effort associated with P/PI/PID loop tuning, system checkout and other required tasks per PART 5 or PART 6 of this specification.

3. EMCS contractor effort, captured under the hours available in this section, is not eligible for change order or additional compensation.

I. ALARMS AND INTERLOCKS:

1. Check each alarm separately by including an appropriate signal at a value that will trip the alarm.
2. Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.
3. Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.

- J. Any tests that cannot be performed due to circumstances beyond the control of the EMCS Contractor may be exempt from the completion requirements if stated as such in writing by the CA. Such tests shall then be performed as part of the warranty.

6.2 COMMISSIONING:

[Engineering Note: Use the following paragraphs for projects **with** separate commissioning specifications such as sections 01810, 15995, 15997, 15998, etc. Otherwise use alternate text provided above as noted. Engineer shall update specification reference numbers and titles as needed for the project]

- A. Prior to acceptance, the [**Commissioning Authority (CA)**] [**Engineering Design Professional (EDP)**] shall subject the EMCS to a series of pre-functional and functional performance tests to verify operation and compliance with specification 01810 GENERAL COMMISSIONING REQUIREMENTS and its associated specifications for Division 15 and 16.
- B. These tests shall occur after the EMCS Contractor has completed the installation, started up the system, and verified system operation as specified in Part 5 - CONTROL SYSTEM CHECKOUT AND TESTING above.
- C. The tests described in this section are to be performed in addition to the tests that the EMCS Contractor performs as a necessary part of the installation, start-up, and debugging process.
- D. The [**CA**] [**EDP**] shall be notified at least 10 days in advance of the readiness of the EMCS Contractor to perform the Functional Performance Tests via the submission of a Certificate of Readiness, signed and dated by the EMCS Contractor.
  1. The Certificate of Readiness is a document, provided by the EMCS Contractor, which states the control system is 100% complete, including all hardware (sensors, actuators, power supplies, etc.), and software (programming, schedules, set up, graphics, etc.), all of the pre-functional testing is complete and that the functional performance tests provided by the [**CA**] [**EDP**] have been reviewed, and fully attempted, and all EMCS controlled equipment, sensors, devices and software algorithms are ready to officially undergo the functional performance testing phase of the commissioning process.

2. Completed documentation required for checkout shall be submitted along with Certificate of Readiness.
- E. The EMCS Contractor shall provide at least two persons equipped with two-way communication. Functional performance test requirements will include testing for all modes of operation including day, night, occupied, unoccupied, low ventilation, fire/smoke alarm, seasonal changeover, and power failure modes. The purpose is to demonstrate the response of each point and system in each mode of operation.
- F. EMCS contractor shall provide eight (8) non-consecutive hours of on-site technical support to be used as directed by the [CA] [EDP] for EDP approved deviations from the contract documents as it applies to the EMCS programming and interfaces. Associated material and equipment costs, if required, are NOT included.
1. These hours shall be used but not limited to the following function types:
    - a. Programming changes to control specified algorithm/ sequence of operations
    - b. Changes to user interface that deviate from EDP specified layouts, graphics, functionality, points, or data.
    - c. Adjustments to schedules or setpoints
    - d. Additional trended points
  2. These hours shall not be used by EMCS contractor for effort associated with P/PI/PID loop tuning, system checkout and other required tasks and scope per PART 5 or PART 6 of this specification.
  3. EMCS contractor effort, captured under the hours available in this section, is not eligible for change order or additional compensation.

### 6.3 FINAL ADJUSTMENT OF EQUIPMENT:

- A. The EMCS Contractor shall be responsible for EMCS start-up, and shall perform all checkout, calibration and testing to ensure proper system operation.
- B. Final adjustment shall be performed by specially trained personnel in the direct employ of the manufacturer of the EMCS Contractor.
- C. Provide system CD-Rom back-ups at all workstations and final manuals.

### 6.4 WARRANTY

- A. **Labor and materials for the EMCS shall be warranted free from defects for a period of twenty four (24) months after final completion and Owner receives beneficial use of the system.** EMCS failures during the warranty period shall be adjusted, repaired or replaced at no additional cost or reduction in service to the Owner. The EMCS Contractor shall respond to the Owner's request for warranty service within 1 hour of complaint or onsite within 4 hours during normal business hours.
- B. All work shall have a single warranty date, even when the Owner has received beneficial use due to an early system start-up. If the work specified is split into multiple contracts or a multi-phase contract, then each contract or phase shall have a separate warranty start date and period.
- C. At the end of the final start-up, and testing phase, if equipment and systems are operating satisfactorily to the EDP [CA] and Owner, the EDP shall sign certificates certifying that the EMCS operation has been tested and accepted in accordance with the terms of this specification. The date of acceptance shall be the start of warranty.
- D. Operator workstation software, project-specific software, graphic software, database software and firmware updates that resolve known software deficiencies as identified by the EMCS Contractor shall be provided at no charge during the warranty period. Any upgrades or functional enhancements associated with the above-mentioned items also can be provided during the warranty period for an additional charge to the Owner. Written authorization by the Owner must, however, be granted prior to the installation of any of the above mentioned items.
- E. Supporting EMCS operation and maintenance services provided during the warranty period shall include:
1. Perform a monthly preventive maintenance service of the system. This may be performed from a remote location. Verify proper system operation of each microprocessor and communication on the network. Review any alarms, schedules, any system overrides, system inputs, etc. and perform corrections or repairs as may be required. Discuss system operation with DCPS staff including scheduling, system setpoints, holiday inputs, etc. and correct deficiencies as required. A monthly service report summarizing findings and actions taken shall be provided documenting that the monthly service was performed.
  2. Perform a comprehensive annual preventive maintenance service of the system just prior to the end of each year of the two-year warranty period. Verify proper operation of the entire system (all points). Any relative humidity or CO2 sensors must be re-calibrated. Physically inspect all central plant and central station AHU controllers for condition and operability. Provide and install software patches, upgrades, etc. as recommended by the manufacturer. Make a back-up copy of the working data base. This service must be performed on-site. An annual service report summarizing findings and actions taken shall be provided documenting that the annual service was performed.

## 6.5 Ownership of Proprietary Material

- A. Project-specific software and documentation shall become Owner's property. This includes, but is not limited to:
1. Graphics
  2. Software to build graphics and program changes
  3. Record drawings
  4. Databases, programs and set up parameters
  5. Application programming code
  6. Documentation for complete operational manuals

END OF SECTION