

20 April 2023
Issue For Bid
SED No. 66-02-02-03-0-001-032
SED No. 66-02-02-03-0-002-029
SED No. 66-02-02-03-0-003-033
SED No. 66-02-02-03-1-010-007
SED No. 66-02-02-03-5-004-008

Croton-Harmon Union Free School District
District-Wide Roofing Project
Croton-Harmon High School
Pierre Van Cortlandt Middle School
Carrie E. Tompkins Elementary School
New Business Office
Croton-Harmon Bus Garage

SECTION 230460 - AUTOMATIC TEMPERATURE CONTROLS

PART 1 - GENERAL

Applicable Provisions of the Conditions of the Contract and Division 1 General Requirements govern work in this section. Submit shop drawings for checking and approval.

Subcontractor must familiarize himself with the terms of the above documents.

1.1 QUALIFICATIONS OF BIDDER

- A. All bidders must be building automation contractors in the business of installing direct digital control building automation systems for a minimum of 10 years.
- B. All bidders must have an office in the within 50 miles of jobsite.
- C. All bidders must be authorized distributors or branch offices of the manufacturers specified.
- D. All bidders must have a trained staff of application Engineers, who have been certified by the manufacturer in the configuration, programming and service of the automation system.

1.2 SCOPE OF WORK

- A. This Contractor shall furnish an electronic system of temperature controls. The District has standardized on Honeywell. All submitted controls shall be directly compatible with existing hardware and software without patch panels or translators or any kind. The ATC Sub-Contractor shall be subject to the District's approval. Communications between the schools is via their Ethernet LAN and remote access is via the Web or Local Intranet. The intent of this specification is to extend and interoperate with this system and to provide a peer-to-peer, networked, distributed control system for the temperature control work that is part of this project. All components, software and operation shall be interoperable with the existing building automation system via the Niagara Framework in the District. The installed system will interface directly with the existing proprietary as well as open protocol systems, including the existing District network, dynamic color graphics software and programming software. The existing software and database will be modified to accept the new equipment being installed under this project to maintain integrity for centralized scheduling, trending, programming and alarming. PC Desktop icons that "link" to a separate EMS system are not acceptable. Any costs associated with connecting to the existing energy management system, including licensed software, programming, training etc. shall be part of the controls contractor's bid. The contractor must demonstrate their ability to perform the integration to the existing Schneider Electric systems prior to submittal acceptance and invoicing.

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- B. Only licensed software toolsets will be acceptable for integration work. All systems as described in the sequence of operation will be shown via dynamic Web based graphics with all pertinent system alarms for proper operation and maintenance. The use of separate PC workstations, gateways, metalinks, replacement of existing controllers and control devices and additional software graphic packages to accomplish this integration will not be accepted.
- C. Prospective bidders shall visit the School District Buildings to verify existing DDC controls equipment and Contractor's ability to be compatible with these controls before bid. Contact the Schools Supt. of Buildings and Grounds for details. Contractor shall provide Web based graphics for controlled equipment that matches the functionality and appearance of the graphics already in use on the existing system. Contractor shall configure graphic display to meet Owner and Engineer requirements.
- D. The Temperature Controls Contractor (TCC) shall provide each of the following portions of the complete EMCS as a standalone system that can communicate with any other DDC system which is following the same protocol.
 - 1. Operator Workstations: Upgrade software and Databases in the district and provide guaranteed seamless two way communications via the Internet and District LAN, including full control, with both all existing DDC systems currently under control and the DDC system provided as a part of this project. The OWS's shall monitor, display, and control information from the DDC systems through one software package. Rebooting of the OWS to access the existing building's multiple systems is not acceptable. Use of separate "Icons" to access multiple DDC systems is not acceptable. The existing database shall be modified to incorporate the work of this project.
 - a. The system OWS's shall meet the hardware and performance requirements of this specification.
 - b. The OWS's shall allow customization of the system as described in this specification.
 - 2. The OWS's shall:
 - a. Provide new color graphic control screens for all equipment provided or modified as part of this project, as outlined below and on the drawings.
 - b. Allow operators to view and work (read and write) all DDC points associated with all DDC equipment provided or modified as part of this project, including all existing DDC points.
 - c. Allow for custom graphics and/or control programming generation for any existing or new equipment.
 - d. Provide seamless continuity of graphics and existing functionality for all existing Owner's equipment currently under DDC control.

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- E. All proposed controls contractors that intend on interoperating with the existing DDC system utilizing DDC controls other than those presently installed in the district, shall submit a Technical Proposal, complete with the diagrams, Specifications Compliance Reports, product information, and supporting documentation outlined below. The technical proposal will be utilized to evaluate the methodology that will be used to implement the interoperation and integration of the new controls of this project into the existing district wide energy management system. It will also be used as a basis for vendor qualification on for the project. Arrange the Technical Proposal in order of the specification article numbers.
1. Provide a list of local jobs (three minimum) of similar type and size the bidder has installed, utilizing the products proposed for this project, with owner's representatives' names and telephone numbers for reference. This list should directly reflect:
 - a. Projects that include direct integration to third party microprocessor controllers of the type specified within the scope where an integration and interoperation of Lon Works controls has been successfully achieved between two different manufacturers' controls systems.
 - i. EMCS network wiring diagram showing interconnection of all panels, workstations, system printer(s) etc. A diagram describing system architecture for this project with product code numbers for workstation, network controllers, application specific controllers, transducers, sensors, communication network, etc.
 2. Provide information on owner training provided as part of the bid package as well as additional opportunities and factory schools available with associated cost. Include details of operator HVAC Training System as specified herein.
 3. Specification Compliance Report. Provide specification compliance report that addresses every paragraph within this specification section utilizing an outline format, as follows:
 - a. Comply-bid package complies without exception;
 - b. Exception – bid package meets the functional intent, but not the letter of the specification. For each paragraph that an exception is taken, identify all deviations from what is specified in the given paragraph and provide a description of what is excluded, what is included, and how the contractor intends to meet the functional intent;
 - c. Does not comply – bid package cannot meet specified function and will not be provided.

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- d. For all paragraphs in this specification section, indicates as "Comply" or "Exception" or "Does not comply". Provide and reference factory product documentation to substantiate compliance.
- 4. Provide a statement that all products used on this project are of current manufacture and are readily available through multiple distribution channels. Products in "field testing" status are not acceptable.
- G. The BAS Contractor shall review and study all HVAC Drawings and the entire Specification to familiarize himself with the equipment and system operation and to verify the quantities and types of dampers, operators, alarms, etc. to be provided.
- H. Prior to commencement of schedule programming meet with Owner to discuss block/individual scheduling of system/equipment and alarm protocols. Review equipment designations and graphics screens to be provided. Take minutes of this meeting and issue them to the Construction Manager/Owner's representative.
- I. All temperature control wiring regardless of voltage shall be done by this Contractor. This shall include power wiring of control panels/components from available spare circuits in electrical panels. The automatic temperature control manufacturer shall provide wiring diagrams, field supervision and one (1) year guarantee on the installed DDC system and three (3) year factory warrantee on all control equipment manufactured by the DDC manufacturer.
- J. Thermostats, temperature sensors, heating control devices, etc. are indicated on the Drawings in general. Provide any additional devices required to carry out project intent as herein described.
- K. Thermostats/Temperature sensors in areas subject to vandalism shall have in addition separately mounted extra heavy guards. Submit sample.
- L. Contractor shall include all new heating control devices, thermostats, etc. indicated on Drawings or that is part of a new system.
- M. Contractor shall furnish all necessary electrical controls, motor starters, switches, etc. for proper operation of equipment furnished by him under this Contract, and as herein noted.
- N. Point and component lists are to be used as a guide. If the sequence of operation requires additional points/control devices, this Contractor shall be responsible for providing same.
- O. All control system components installed shall be manufactured by the DDC system manufacturer.

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- P. Communications cabling shall be run in hallways above hung ceiling with plenum cable and wiremold where exposed.
- Q. Removals shall include switches, relays, electric components not required for the new intent. Do not leave behind items with no function. Provide appropriate blanking plates/patching where removals occur in finished spaces.
- R. Provide services and manpower necessary for commissioning of system in coordination with the HVAC Contractor, Balancing Contractor, Owner's representative, and Commissioning Authority.

1.3 SOFTWARE CODE

- A. Owner shall be furnished with a complete, hard-bound copy of all installed software code. Final payment shall be contingent upon this requirement being met.

1.4 CODE COMPLIANCE

- A. Provide components and ancillary equipment, which are UL-916 listed and labeled.
- B. All equipment or piping used in conditioned air streams, spaces or return air plenums shall comply with NFPA 90A Flame/Smoke/Fuel contribution rating of 25/50/0 and all applicable building codes or requirements.
- C. All wiring shall conform to the National Electrical Code.
- D. Comply with FCC rules, Part 15 regarding Class A radiation for computing devices and low power communication equipment operating in commercial environments.
- E. Comply with FCC, Part 68 rules for telephone modems and data sets.

1.5 SUBMITTALS

- A. All shop drawings shall be prepared in Visio Professional or AutoCAD software. In addition to the Drawings, the Contractor shall furnish a CD containing the identical information. Drawings shall be B size or larger.
- B. Shop drawings shall include a riser diagram depicting locations of all controllers and workstations, with associated network wiring. Also included shall be individual schematics of each mechanical system showing all connected points with reference to their associated controller. Typical will be allowed where appropriate.
- C. Submittal data shall contain manufacturer's data on all hardware and software products required by the Specification. Valve damper and airflow station schedules shall indicate size, configuration, capacity and location of all equipment.

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- D. Software submittals shall contain narrative descriptions of sequences of operation, program listings, point lists, and a complete description of the graphics, reports, alarms and configuration to be furnished with the workstation software. Information shall be bound or in a three ring binder with an index and tabs.
- E. Submit submittal data and shop drawings to the Engineer for review prior to ordering or fabrication of the equipment. The Contractor prior to submitting shall check all Documents for accuracy.
- F. The Engineer will make corrections, if required, and return to the Contractor. The Contractor will then resubmit with the corrected or additional data. This procedure shall be repeated until all corrections are made to the satisfaction of the Engineer and the submittals are fully approved.

1.6 SYSTEM STARTUP AND COMMISSIONING

- A. Each point in the system shall be tested for both hardware and software functionality. In addition, each mechanical and electrical system under control of the BAS will be tested against the appropriate sequence of operation specified herein. Successful completion of the system test shall constitute the beginning of the commissioning phase. A written report will be submitted to the Owner indicating that the installed system has been started and balanced in accordance with the Drawings and Specifications.
- B. The ATC Contractor shall set in operating condition all major equipment and systems, such as heating, cooling, heat recovery and all air handling systems, in the presence of the equipment manufacturer's representatives, as applicable, and the Owner and Architect's representatives. The ATC contractor shall work with the Commissioning Authority as required until all associated HVAC equipment is fully commissioned to the satisfaction of the Commissioning Authority.
- C. The ATC Contractor shall provide all manpower and engineering services required to assist the HVAC Contractor, Balancing Contractor, and Commissioning Authority in testing, adjusting, and balancing all systems in the building Scope of Work. The Contractor shall have a trained technician available on request during the balancing and commissioning of the systems. The Contractor shall coordinate all requirements to provide a complete air balance with the Balancing Contractor and Commissioning Authority and shall include all labor and materials in his Contract.
- D. Refer to specification section 23 0485 HVAC Systems Commissioning.

1.7 OPERATING AND MAINTENANCE MANUALS

- A. The operation and maintenance manuals shall contain all information necessary for the operation, maintenance, replacement, installation and parts procurement for the entire system. This documentation shall include specific part numbers and software versions and dates. A complete list of recommended spare parts shall be included with the lead-

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time and expected frequency of use of each part clearly identified.

- B. Following project completion and testing, the Contractor will submit As-Built Drawings reflecting the exact installation of the system. The as-built documentation shall also include a copy of all application software both in written form and on CD.

1.8 WARRANTY

- A. The Contractor shall provide system warranty for 12 months after system acceptance or beneficial use by the Owner. During the warranty period, the Contractor shall be responsible for all necessary revisions to the software as required to provide a complete and workable system consistent with the letter and intent of the Sequence of Operation section of the Specification.
- B. Updates to the manufacturer's software shall be provided at no charge during the warranty period.

1.9 SPECIFICATION NOMENCLATURE

- A. Acronyms used in this specification are as follows:
 - 1. EMCS Energy Management and Control System
 - 2. NAC Network Area Controller
 - 3. IDC Interoperable Digital Controller
 - 4. FUI Full User Interface
 - 5. BUI Browser User Interface
 - 6. POT Portable Operator's Terminal
 - 7. PMI Power Measurement Interface
 - 8. DDC Direct Digital Controls
 - 9. LAN Local Area Network
 - 10. WAN Wide Area Network
 - 11. OOT Object Oriented Technology
 - 12. PICS Product Interoperability Compliance Statement

PART 2 - PRODUCTS

2.1 GENERAL

- A. The Energy Management Control System (EMCS) shall be comprised of a network of interoperable, stand-alone digital controllers, a computer system, graphical user interface software, portable operator terminals, printers, network devices and other devices as specified herein.
- B. The installed system shall provide secure password access to all features, functions and data contained in the overall EMCS.

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2.2 OPEN, INTEROPERABLE, INTEGRATED ARCHITECTURES

- A. The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system with the capability to integrate Lon Works and Schneider Electric Network 8000 technology communication protocols in one open, interoperable system.
- B. The programming computer software shall employ object-oriented technology (OOT) for representation of all data and control devices within the system. In addition, adherence to industry standards including ANSI / ASHRAE™ Standard 135-1995, to assure interoperability between all system components is required. For each Lon Works device that does not have Lon Work certification, the device supplier must provide an XIF file for the device. All components and controllers supplied under this contract shall be true “peer-to-peer” communicating devices. Components or controllers requiring “polling” by a host to pass data shall not be acceptable.
- C. The supplied system must incorporate the ability to access all data using Java enabled browsers without requiring proprietary operator interface and configuration programs. An Open Database Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data shall reside on a supplier-installed server for all database access. Systems requiring proprietary database or proprietary user interface programs shall not be acceptable.
- D. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer’s internal Intranet network. Systems employing a “flat” single tiered architecture shall not be acceptable.
 - 1. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 5 seconds for network connected user interfaces.
 - 2. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 60 seconds for remote or dial-up connected user interfaces.

2.3 NETWORKS

- A. The Local Area Network (LAN) shall be either a 10 or 100 Megabits/sec Ethernet network supporting, Java, XML, HTTP, and CORBA IIOP for maximum flexibility for integration of building data with enterprise information systems and providing support for multiple Network Area Controllers (NACs), Browser User Interfaces (BUIs) and/or Full User Interfaces (FUIs).

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- B. Local area network minimum physical and media access requirements:
1. Ethernet; IEEE standard 802.3
 2. Cable; 10 Base-T, UTP-8 wire, category 5
 3. Minimum throughput; 10 Mbps, with ability to increase to 100 Mbps

2.4 NETWORK ACCESS

A. Remote Access

1. For Local Area Network installations, provide access to the LAN from a remote location, via the Internet. The owner shall provide a connection to the Internet to enable this access via high-speed cable modem, asynchronous digital subscriber line (ADSL) modem, and ISDN line, T1 Line or via the customer's Intranet to a corporate server providing access to an Internet Service Provider (ISP). Owner agrees to pay monthly access charges for connection and ISP.
2. Where no Local Area Network exists, EMCS supplier shall provide the following:
 - a. 8 Port Ethernet hub (3Com, or equal)
 - b. Ethernet router (Cisco or equal)
3. The owner shall provide a connection to the Internet to enable this access via high-speed cable modem, asynchronous digital subscriber line (ADSL) modem, ISDN line or T1 Line. Owner agrees to pay monthly access charges for connection and ISP.

2.5 NETWORK AREA CONTROLLER (NAC)

- A. The Network Area Controller (NAC) shall provide the interface between the LAN or WAN and the field control devices and provide global supervisory control functions over the control devices connected to the NAC. It shall be capable of executing application control programs to provide:
1. Calendar functions
 2. Scheduling
 3. Trending
 4. Alarm monitoring and routing
 5. Time synchronization
 6. Integration of Lon Works controller data
 7. Network Management functions for all Lon Works based devices
- B. The Network Area Controller must provide the following hardware features as a minimum:
1. One Ethernet Port -10 / 100 Mbps.
 2. One RS-232 port.
 3. One Lon Works Interface Port – 78KB FTT-10A.
 4. Battery Backup.

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5. Flash memory for long term data backup (If battery backup or flash memory is not supplied, the controller must contain a hard disk with at least 1 gigabyte storage capacity)
 6. The NAC must be capable of operation over a temperature range of 0 to 55°C.
 7. The NAC must be capable of withstanding storage temperatures of between 0 and 70°C.
 8. The NAC must be capable of operation over a humidity range of 5 to 95% RH, non-condensing.
- C. The NAC shall provide multiple user access to the system and support for ODBC or SQL. A database resident on the NAC shall be an ODBC-compliant database or must provide an ODBC data access mechanism to read and write data stored within it.
- D. The NAC shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 16 simultaneous users.
- E. Event Alarm Notification and Actions
1. The NAC shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
 2. The NAC shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via dial-up, telephone connection, or wide-area network.
 3. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but limited to:
 - a. To alarm
 - b. Return to normal
 - c. To fault
 4. Provide for the creation of an unlimited number of alarm classes for the purpose of routing types and or classes of alarms, i.e.: security, HVAC, Fire, etc.
 5. Provide timed (schedule) routing of alarms by class, object, group, or node.
 6. Provide alarm generation from binary object "runtime" and /or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.
- F. Control equipment and network failures shall be treated as alarms and annunciated.
- G. Alarms shall be annunciated in any of the following manners as defined by the user:
1. Screen message text
 2. Email of the complete alarm message to multiple recipients. Provide the ability to route and email alarms based on:
 - a. Day of week
 - b. Time of day

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- c. Recipient
 - 3. Pagers via paging services that initiate a page on receipt of email message
 - 4. Graphic with flashing alarm object(s)
 - 5. Printed message, routed directly to a dedicated alarm printer
- H. The following shall be recorded by the NAC for each alarm (at a minimum):
- 1. Time and date
 - 2. Location (building, floor, zone, office number, etc.)
 - 3. Equipment (air handler #, access way, etc.)
 - 4. Acknowledge time, date, and user who issued acknowledgement.
 - 5. Number of occurrences since last acknowledgement.
- I. Alarm actions may be initiated by user defined programmable objects created for that purpose.
- J. Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.
- K. A log of all alarms shall be maintained by the NAC and/or a server (if configured in the system) and shall be available for review by the user.
- L. Provide a "query" feature to allow review of specific alarms by user-defined parameters.
- M. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.
- N. An Error Log to record invalid property changes or commands shall be provided and available for review by the user.
- 2.6 DATA COLLECTION AND STORAGE
- A. The NAC shall have the ability to collect data for any property of any object and store this data for future use.
 - B. The data collection shall be performed by log objects, resident in the NAC that shall have, at a minimum, the following configurable properties:
 - 1. Designating the log as interval or deviation.
 - 2. For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.
 - 3. For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.

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4. For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis.
 5. Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.
- C. All log data shall be stored in a relational database in the NAC and the data shall be accessed from a server (if the system is so configured) or a standard Web Browser.
- D. All log data, when accessed from a server, shall be capable of being manipulated using standard SQL statements.
- E. All log data shall be available to the user in the following data formats:
1. HTML
 2. XML
 3. Plain Text
 4. Comma or tab separated values
- F. Systems that do not provide log data in HTML and XML formats at a minimum shall not be acceptable.
- G. The NAC shall have the ability to archive its log data either locally (to itself), or remotely to a server or other NAC on the network. Provide the ability to configure the following archiving properties, at a minimum:
1. Archive on time of day.
 2. Archive on user-defined number of data stores in the log (buffer size).
 3. Archive when log has reached its user-defined capacity of data stores.
 4. Provide ability to clear logs once archived.

2.7 AUDIT LOG

- A. Provide and maintain an Audit Log that tracks all activities performed on the NAC. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached its user-defined buffer size. Provide the ability to archive the log locally (to the NAC), to another NAC on the network, or to a server. For each log entry, provide the following data:
1. Time and date
 2. User ID
 3. Change or activity: i.e., Change setpoint, add or delete objects, commands, etc.

2.8 DATABASE BACKUP AND STORAGE

- A. The NAC shall have the ability to automatically backup its database. The database shall be backed up based on a user-defined time interval.

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- B. Copies of the current database and, at the most recently saved database shall be stored in the NAC. The age of the most recently saved database is dependent on the user-defined database save interval.
- C. The NAC database shall be stored, at a minimum, in XML format to allow for user viewing and editing, if desired. Other formats are acceptable as well, as long as XML format is supported.

2.9 INTEROPERABLE DIGITAL CONTROLLER (IDC)

- A. Controls shall be microprocessor based Interoperable Lon Mark™ or Lon Works Controllers (IDC). Where possible, all Interoperable Digital Controllers shall bear the applicable Lon Mark™ interoperability logo on each product delivered.
- B. HVAC control shall be accomplished using Lon Mark™ based devices where the application has a Lon Mark profile defined. Where Lon Mark devices are not available for a particular application, devices based on Lon Works shall be acceptable. For each Lon Works device that does not have Lon Mark certification, the device supplier must provide an XIF file for the device. Publicly available specifications for the Applications Programming Interface (API) must be provided for each Lon Works / Lon Mark controller defining the programming or setup of each device. All programming, documentation and programming tools necessary to set up and configure the supplied devices per the specified sequences of operation shall be provided.
- C. The Lon Works network trunk shall be run to the nearest Network Area Controller (NAC). A maximum of 126 devices may occupy any one Lon Works trunk and must be installed in buss architecture using the appropriate trunk termination device. All Lon Works and Lon Mark devices must be supplied using FTT-10A Lon Works communications transceivers.
- D. The Network Area Controller will provide all scheduling, alarming, trending, and network management for the Lon Mark / Lon Works based devices.
- E. The IDCs shall communicate with the NAC at a baud rate of not less than 78.8K baud. The IDC shall provide LED indication of communication and controller performance to the technician, without cover removal.
- F. All IDCs shall be fully application programmable and shall at all times maintain their LONMARK certification. Controllers offering application selection only (non-programmable), require a 10% spare point capacity to be provided for all applications. All control sequences within or programmed into the IDC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained.
- G. The supplier of any programmable IDC shall provide one copy of the manufacturer's programming tool, with documentation, to the owner.

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2.10 FULL USER INTERFACE SOFTWARE

- A. Operating System: The FUI shall run on Microsoft Windows NT Workstation 4.0, Service Pack 4 or later.
- B. The FUI shall employ browser-like functionality for ease of navigation. It shall include a tree view (similar to Windows Explorer) for quick viewing of, and access to, the hierarchical structure of the database. In addition, menu-pull downs, and toolbars shall employ buttons, commands and navigation to permit the operator to perform tasks with a minimum knowledge of the HVAC Control System and basic computing skills. These shall include, but are not limited to, forward/backward buttons, home button, and a context sensitive locator line (similar to a URL line), that displays the location and the selected object identification.
- C. Real-Time Displays. The FUI, shall at a minimum, support the following graphical features and functions:
 - 1. Graphic screens shall be developed using any drawing package capable of generating a GIF, BMP, or JPG file format. Use of proprietary graphic file formats shall not be acceptable. In addition to, or in lieu of a graphic background, the FUI shall support the use of scanned pictures.
 - 2. Graphic screens shall have the capability to contain objects for text, real-time values, animation, color spectrum objects, logs, graphs, HTML or XML document links, schedule objects, hyperlinks to other URL's, and links to other graphic screens.
 - 3. Graphics shall support layering and each graphic object shall be configurable for assignment to a layer. A minimum of six layers shall be supported.
 - 4. Modifying common application objects, such as schedules, calendars, and set points shall be accomplished in a graphical manner.
 - a. Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
 - b. Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.
 - 5. Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.
 - 6. Adjustments to analog objects, such as set points, shall be done by right-clicking the selected object and using a graphical slider to adjust the value. No entry of text shall be required.

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- D. System Configuration: At a minimum, the FUI shall permit the operator to perform the following tasks, with proper password access:
1. Create, delete or modify control strategies.
 2. Add/delete objects to the system.
 3. Tune control loops through the adjustment of control loop parameters.
 4. Enable or disable control strategies.
 5. Generate hard copy records or control strategies on a printer.
 6. Select points to be alarmable and define the alarm state.
 7. Select points to be trended over a period of time and initiate the recording of values automatically.
- E. On-line Help: Provide a context sensitive, on-line help system to assist the operator in operation and editing of the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext. All system documentation and help files shall be in HTML format.
- F. On-line Documentation: Provide a context sensitive, on-line documentation system to assist the operator in operation and trouble shooting of each integrated system. On-line help shall be available for all applications and shall provide the relevant data for that particular monitoring screen. As a minimum, provide a link to the Sequence of Operation, input/output summary, and cut sheets in either Adobe Acrobat™ or HTML format.
- G. Security: Each operator shall be required to log on to that system with a username and password in order to view, edit, add, or delete data. System security shall be selectable for each operator. The system administrator shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the operators' access for viewing and/or changing each system application, full screen editor, and object. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected. This auto log-off time shall be set per operator password. All system security data shall be stored in an encrypted format.
- H. System Diagnostics: The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers. The failure of any device shall be annunciated to the operator.
- I. Alarm Console
1. The system will be provided with a dedicated alarm window or console. This window will notify the operator of an alarm condition and allow the operator to view details of the alarm and acknowledge the alarm. The use of the Alarm Console can be enabled or disabled by the system administrator.

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2. When the Alarm Console is enabled, a separate alarm notification window will supersede all other windows on the desktop and shall not be capable of being minimized or closed by the operator. This window will notify the operator of new alarms and un-acknowledged alarms. Alarm notification windows or banners that can be minimized or closed by the operator shall not be acceptable.

2.11 BROWSER USER INTERFACE SOFTWARE

- A. The system shall be capable of supporting an unlimited number of clients using a standard Web browser such as Internet Explorer™ or Netscape Navigator™. Systems requiring additional software (to enable a standard Web browser) to be resident on the client machine, or manufacture-specific browsers shall not be acceptable.
- B. The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Systems that require specific machine requirements in terms of processor speed, memory, etc., in order to allow the Web browser to function with the EMCS, shall not be acceptable.
- C. The Web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Full User Interface. Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.
- D. The Web browser client shall support at a minimum, the following functions:
 1. User log-on identification and password shall be required. If an unauthorized user attempts access, a blank web page shall be displayed. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.
 2. Graphical screens developed for the FUI shall be the same screens used for the Web browser client. Any animated graphical objects supported by the FUI shall be supported by the Web browser interface.
 3. HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.
 4. Storage of the graphical screens shall be in the Network Area Controller (NAC), without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.
 5. Real-time values displayed on a Web page shall update automatically without requiring a manual "refresh" of the Web page.
 6. Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:
 - a. Modify common application objects, such as schedules, calendars, and set points in a graphical manner.

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- Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
 - Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.
- b. Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.
- c. View logs and charts
- d. View and acknowledge alarms
- 7. The system shall provide the capability to specify a user's (as determined by the log-on user identification) home page. Provide the ability to limit a specific user to a pre-defined home page. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.
- 8. Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

2.12 SYSTEM PROGRAMMING

- A. The Full User Interface software (FUI) shall provide the ability to perform system programming and graphic display engineering as part of a complete software package. Access to the programming functions and features of the FUI shall be through password access as assigned by the system administrator.
- B. A library of control, application, and graphic objects shall be provided to enable the creation of all applications and user interface screens. Applications are to be created by selecting the desired control objects from the library, dragging or pasting them on the screen, and linking them together using a built in graphical connection tool. Completed applications may be stored in the library for future use. Graphical User Interface screens shall be created in the same fashion. Data for the user displays is obtained by graphically linking the user display objects to the application objects to provide "real-time" data updates. Any real-time data value or object property may be connected to display its current value on a user display. Systems requiring separate software tools or processes to create applications and user interface display shall not be acceptable.

Programming Methods

- 1. Provide the capability to copy objects from the supplied libraries, or from a user-defined library to the user's application. Objects shall be linked by a graphical linking scheme by dragging a link from one object to another. Object links will support one-to-one, many-to-one, or one-to-many relationships. Linked objects shall maintain their connections to other objects regardless of where they are positioned on the page and shall show link identification for links to objects on other pages for easy identification. Links will vary in color depending on the type of link; i.e., internal, external, hardware, etc.

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2. Configuration of each object will be done through the object's property sheet using fill-in the blank fields, list boxes, and selection buttons. Use of custom programming, scripting language, or a manufacturer-specific procedural language for configuration will not be accepted.
3. The software shall provide the ability to view the logic in a monitor mode. When on-line, the monitor mode shall provide the ability to view the logic in real time for easy diagnosis of the logic execution. When off-line (debug), the monitor mode shall allow the user to set values to inputs and monitor the logic for diagnosing execution before it is applied to the system.
4. All programming shall be done in real-time. Systems requiring the uploading, editing, and downloading of database objects shall not be allowed.
5. The system shall support object duplication within a customer's database. An application, once configured, can be copied and pasted for easy re-use and duplication. All links, other than to the hardware, shall be maintained during duplication.

2.13 OBJECT LIBRARIES

- A. A standard library of objects shall be included for development and setup of application logic, user interface displays, system services, and communication networks.
- B. The objects in this library shall be capable of being copied and pasted into the user's database and shall be organized according to their function. In addition, the user shall have the capability to group objects created in their application and store the new instances of these objects in a user-defined library.
- C. In addition to the standard libraries specified here, the supplier of the system shall maintain an on-line accessible (over the Internet) library, available to all registered users to provide new or updated objects and applications as they are developed.
- D. The object library shall include objects to support the integration of devices connected to the Network Area Controller (NAC). At a minimum, provide the following as part of the standard library included with the programming software:
 1. Lon Mark/Lon Works devices. These devices shall include, but not be limited to, devices for control of HVAC, lighting, access, and metering. Provide Lon Mark manufacturer-specific objects to facilitate simple integration of these devices. All network variables defined in the Lon Mark profile shall be supported. Information (type and function) regarding network variables not defined in the Lon Mark profile shall be provided by the device manufacturer.
 2. For devices not conforming to the Lon Mark standard, provide a dynamic object that can be assigned to the device based on network variable information provided by the device manufacturer. Device manufacturer shall provide an XIF file and documentation for the device to facilitate device integration.

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2.14 LONWORKS NETWORK MANAGEMENT

- A. The Full User Interface software (FUI) shall provide a complete set of integrated Lon Works network management tools for working with Lon Works networks. These tools shall manage a database for all Lon Works devices by type and revision, and shall provide a software mechanism for identifying each device on the network. These tools shall also be capable of defining network data connections between Lon Works devices, known as "binding". Systems requiring the use of third party Lon Works network management tools shall not be accepted.
- B. Network management shall include the following services: device identification, device installation, device configuration, device diagnostics, device maintenance and network variable binding.
- C. The Network configuration tool shall also provide diagnostics to identify devices on the network, to reset devices, and to view health and status counters within devices.
- D. These tools shall provide the ability to "learn" an existing Lon Works network, regardless of what network management tool(s) were used to install the existing network, so that existing Lon Works devices and newly added devices are part of a single network management database.
- E. The network management database shall be resident in the Network Area Controller (NAC), ensuring that anyone with proper authorization has access to the network management database at all times. Systems employing network management databases that are not resident, at all times, and within the control system shall not be accepted.

2.15 OTHER CONTROL SYSTEM HARDWARE

- A. Motorized Control Dampers: Coordinate with the other trades for the exact quantity, size and location of all dampers. Dampers shall be black enamel finish or galvanized, with nylon bearings. Blade edge and tip seals shall be included for all dampers. Blades shall be 16-gauge minimum and 6 inches wide maximum and frame shall be of welded channel iron. Dampers with both dimensions less than 18 inches may have strap iron frames. Ruskin CD-46 or Equal.
- B. Control Damper and Valve Actuators: Coordinate with other trades for exact quantity, size and location of all dampers. Provide all dampers unless Two-position or proportional electric actuators shall be direct-mount type. All actuators shall be spring return type. Provide one actuator per damper minimum.
- C. Control Valves: Control valves shall be 2-way or 3-way pattern as shown constructed for tight shutoff and shall operate satisfactorily against system pressures and differentials. Two-position valves shall be 'line' size. Proportional control valves shall be sized for a maximum pressure drop of 5.0 psi at rated flow (except as may be noted on the

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drawings). Valves with sizes up to and including 2 inches shall be "screwed" configuration and 2-1/2 inch and larger valves shall be "flanged" configuration. Electrically controlled valves shall include spring return type actuators sized for tight shut-off against system pressures and furnished with integral switches for indication of valve position (open-closed). Three-way butterfly valves, when utilized, shall include a separate actuator for each butterfly segment.

- D. Wall Mount Room Thermostats: Each room thermostat shall provide temperature indication to the digital controller; provide the capability for a software-limited set point adjustment and operation override capability. An integral LCD shall annunciate current room temperature and set point as well as override status indication. In addition, the thermostat shall include a port for connection of the portable operator's terminal described elsewhere in this specification.
- E. Duct Mount, Pipe Mount and Outside Air Temperature Sensors: 10,000-ohm thermistor temperature sensors with an accuracy of $\pm 0.2^{\circ}\text{C}$. Outside air sensors shall include an integral sun shield.
- F. Current Sensitive Switches: Solid state, split core current switch that operates when the current level (sensed by the internal current transformer) exceeds the adjustable trip point. Current switch to include an integral LED for indication of trip condition and a current level below trip set point.
- G. Water Flow Meters (when required): Water flow meters shall be axial turbine style flow meters which translate liquid motion into electronic output signals proportional to the flow sensed. Flow sensing turbine rotors shall be non-metallic and not impaired by magnetic drag. Flow meters shall be 'insertion' type complete with 'hot-tap' isolation valves to enable sensor removal without water supply system shutdown. Accuracy shall be $\pm 2\%$ of actual reading from 0.4 to 20 feet per second flow velocities.
- H. Temperature Control Panels: Furnish temperature control panels of code gauge steel with locking doors for mounting all devices as shown. Control panels shall meet all requirements of Title 24, California Administrative Code. All electrical devices within a control panel shall be factory wired. All external wiring shall be connected to terminal strips mounted within the panel. Provide engraved phenolic nameplates identifying all devices mounted on the face of control panels. A complete set of 'as-built' control drawings (relating to the controls within that panel) shall be furnished within each control panel.

2.16 INPUT DEVICES

- A. System accuracy of sensed conditions shall be as follows:
 - 1. $\pm .5^{\circ}\text{F}$ for space temperature in the $0-130^{\circ}\text{F}$ range
 - 2. $\pm .5^{\circ}\text{F}$ for duct temperatures in the $40-130^{\circ}\text{F}$ range

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3. +/- 1.0°F for outside air temperatures in the (-30)-230°F range
 4. +/- 1.0°F for water temperatures in the 30-230°F range
 5. +/- .1 inch for filter status differential over a 0-2 inch range
- B. The system shall maintain the specified analog end-to-end accuracy throughout the warranty period from sensor to controller readout.
- C. Packaging: Sensors (transducers) will be appropriately packaged for the location.
1. Architectural housing for space mounting.
 2. Weatherproof/sunshield housing for outdoors.
 3. Thermal well housing for water applications.
 4. Protective housing for duct mounting.
- D. Environmental Ratings - The sensor/transducer shall be selected to withstand ambient conditions where:
1. Moisture or condensation is a factor.
 2. Vibration exists from ductwork, equipment, etc.
 3. Reasonably expected transient conditions exist for temperatures, pressures, humidity's, etc. outside the normal sensing range.
- E. Temperature Sensors
1. Temperature sensors will be by the use of thermistors (10K ohm at 77°F) or RTDs (PT100 curve).
 2. Sensors in the return or discharge duct shall be of the single point type. Sensors in the mixed air will be of the average type.
 3. Thermowells shall be brass or stainless steel for non-corrosive fluids below 250°F and 300 series stainless steel for all other applications.
 4. Room temperature sensors: Sensing element only.
- F. Digital Sensors
1. All digital inputs will be provided by dry contacts. The contacts will be wired normally open or normally closed as required.
 2. Motor status (pumps, fans, etc.) shall be determined by current-operated switch.
- 2.17 OUTPUT DEVICES
- A. The use of multiplexers will not be accepted.
- B. Relays and Contactors

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1. All digital outputs will be electrically isolated from the digital controller by interface relays.
2. Field relays shall have a minimum life of 1 million cycles without failure.
3. Contactors shall have a minimum life of ten thousand cycles without failure.

2.18 ACTUATORS

- A. Standard manufacturer damper and valve actuators, proportional or two-position as required, sized to properly operate device. Damper actuators shall be of the direct coupled type, Belimo or equal.

2.19 WIRING AND CONDUIT

- A. Where different wiring classes terminate within the same enclosure, maintain clearances and install barriers per the National Electric Code.
- B. Where wiring is required to be installed in conduit, EMT shall be used. Conduit shall be minimum 1/2 inch galvanized EMT. Set screw fittings are acceptable for dry interior locations. Watertight compression fittings shall be used for exterior locations and interior locations subject to moisture. Provide conduit seal-off fitting where exterior conduits enter the building or between areas of high temperature/moisture differential.
- C. Flexible metallic conduit (max. 3 feet) shall be used for connections to motors, actuators, controllers, and sensors mounted on vibration producing equipment. Liquid-tight flexible conduit shall be use in exterior locations and interior locations subject to moisture.
- D. Junction boxes shall be provided at all cable splices, equipment terminations, and transitions from EMT to flexible conduit. Interior dry location J-boxes shall be galvanized pressed steel, nominal four-inch square with blank cover. Exterior and damp location JH-boxes shall be cast alloy FS boxes with threaded hubs and gasketed covers.
- E. Where the space above the ceiling is a supply or return air plenum, the wiring shall be plenum rated. Teflon wiring can be run without conduit above suspended ceilings. EXCEPTION: Any wire run in suspended ceilings that is used to control outside air dampers or to connect the system to the fire alarm system shall be in conduit.

2.20 ENCLOSURES

- A. All controllers and field interface panels shall be mounted in new enclosures unless otherwise stated in this specification.
- B. All outside mounted enclosures shall meet the NEMA-4 rating.
- C. Wiring within all enclosures shall be run in plastic track. Wiring within controllers shall be wrapped and secured.

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2.21 CONTROL VALVES

- A. Control Valves: Factory fabricated, of type, body material, and pressure class indicated. Where type or body material is not indicated, make selection as determined by manufacturer for installation requirements and pressure class, based on maximum pressure and temperature rating of piping system.
- B. Globe Pattern: As follows:
1. Up to 2 inches: Bronze body, bronze trim, rising stem, renewable composition disc, screwed ends with backseating capacity re-packable under pressure.
 2. Over 2 inches: Iron body, bronze trim, rising stem, plug-type disc, flanged ends, renewable seat and disc.
 3. Hydronic Systems: As follows:
 - a. Rating: Service at 125 psi WSP and 250°F.
 - b. Internal Construction: Replaceable plugs and seats of stainless steel or brass.
 - Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom of guided plugs.
 - Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom of guided plugs.
 - c. Sizing: 3-psi maximum pressure drop at design flow rate.
 - d. Flow Characteristics: 2-way valves have equal percentage characteristics; 3-way valves have linear characteristics. Select operators to close valves against pump shutoff head.
- C. Terminal Unit Control Valves: Bronze body, bronze trim, 2 or 3 port as indicated, replaceable plugs and seats, union and threaded ends.
1. Rating: Service at 125 psi WSP and 250°F.
 2. Sizing: 3-psi maximum pressure drop at design flow rate, to close against pump shutoff head.
 3. Flow Characteristics: 2-way valves have equal percentage characteristics; 3-way valves have linear characteristics.
 4. Operators (2 Position): Synchronous motor with enclosed gear train, dual-return springs, valve-position indicator. Valves spring return to normal position for temperature protection.

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5. Operators (Modulating): Self-contained, linear motor, actuator with 60-second full travel, with transformer and single-throw, double-pole contacts.

2.22 DAMPERS

- A. Dampers: AMCA-rated, parallel or opposed blade design; form frames from not less than 0.1084-inch galvanized steel with mounting holes for duct mounting; damper blades not less than 0.0635-inch galvanized steel, with maximum blade width of 8 inches.
 1. Blades secured to 1/2-inch diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass. Ends sealed against spring-stainless-steel blade bearings. Thrust bearings at each end of every blade.
 2. Operating Temperature Range: From -40 to 200°F.
 3. For standard applications as indicated, (as selected by manufacturer's sizing techniques) with optional closed-cell neoprene edging.
 4. Provide low-leakage parallel or opposed blade design (as selected by manufacturer's sizing techniques) with inflatable seal blade edging, or replaceable rubber seals, rated for leakage at less than 10 cfm/sq.ft. of damper area, at differential pressure of 4 inches wg when damper is being held by torque of 50 inch-pounds; test in accordance with AMCA 500. Ruskin CD-46 or equal.

2.23 ACTUATORS

- A. Electronic Actuators: The actuator shall be direct coupled over the shaft, enabling it to be mounted directly to the damper shaft without the need for connecting linkage. The actuator shall have electronic overload circuitry to prevent damage. For power-failure/safety applications, an internal mechanical, spring return mechanism shall be built into the actuator housing. Non-spring return actuators shall have an external manual gear release to allow positioning of the damper when the actuator is not powered.
- B. All valves shall be fully proportioning, unless otherwise specified, quiet in operation, and shall be arranged to fail safe, in either a normally open or normally closed position, in the event of power failure. The open or closed position shall be as specified or as required to suit job conditions. All valves shall be capable of operating at varying rates of speed to correspond to the exact dictates of the controller and variable load requirements.
- C. Where valves operate in sequence with other valves or damper operators, provide on each valve a pilot positioner to provide adjustable operating ranges and starting points and positive close off at the required control signal pressure. Positioners must be directly connected to the valve stem. Ratio relays are not acceptable.

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- D. Valves shall be sized by the Temperature Control Manufacturer and guaranteed to meet the heating or requirements as specified and indicated on the Drawings. Unless otherwise specified, all shall conform to the requirements herein specified for the piping system in which they are installed.

2.24 CENTRAL CONTROL PANEL

- A. Integrate new controls into existing central control touch screen panel. This central panel will allow for time clock scheduling, setpoints, monitoring of points and alarm. All freezestats will be reset manually at the central panel. All alarms will be displayed and reset manually at central panel.
- B. All exhaust fans shall be controlled by the central control panel.
- C. Central control panel shall be connected to existing District IT Network. District shall provide data drop.

2.25 AUXILIARY EQUIPMENT/DEVICES

A. Analog Sensors

1. Duct sensors (greater than four square feet): Monitoring range to suit application. Platinum or nickel wound RTD Type + 0.1% of range. Factory calibration point – 70 Deg. F at 1000 OHMS.
2. Space Temperature Sensors: Space Temperature Sensors shall be 5,000 or 10,000 ohm thermistor with wall plate adapter and blank cover assembly. The sensor shall include an integral occupancy override button and shall also include a RJ11 communications port. Space Temperature Sensors shall include space temperature adjustment slides where shown on the plans. The Space Temperature Sensors shall be mounted approximately 60" above the floor.
3. Hydronic Well Temperature Sensors: Water Temperature Sensors shall be well mounted 5,000 or 10,000 ohm thermistors.
4. Status Indication- Status indication for fans and pumps shall be provided by a current sensing sensor. The sensor shall be installed at the motor starter or motor to provide load indication. The unit shall consist of a current transformer, a solid state current sensing circuit (with adjustable set point) and a solid state switch. A red light emitting diode (LED) shall indicate the on off status of the unit. The switch shall provide a N.O. contact for wiring back to the Field Installed Controller.

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5. Combination CO₂ and Space Temperature Sensors: CO₂ and space sensors are comprised of two sensors housed in one unit designed to measure both CO₂ in the air and the building air temperature. Combination sensor shall have the following features:
 - a. Self Calibration CO₂ sensor with 5 year calibration interval.
 - b. Push button over ride.
 - c. CO₂ sensitivity +/- 20 ppm.
 - d. CO₂ accuracy +/- 100 ppm.
 - e. Space sensor: 5 or 10K thermistor.

2.26 DDC SENSORS AND POINT HARDWARE

A. Temperature Sensors

1. All temperature devices shall use precision thermistors accurate to +/- 1 degree F over a range of -30 to 230 degrees F. Space temperature sensors shall be accurate to +/- .5 degrees F over a range of 40 to 100 degrees F.
2. Standard space sensors shall be available in an off white enclosure for mounting on a standard electrical box.
3. Where manual overrides are required, the sensor housing shall feature both an optional sliding mechanism for adjusting the space temperature setpoint, as well as a push button for selecting after hours operation.
4. Where a local display is specified, the sensor shall incorporate either an LED or LCD display for viewing the space temperature, setpoint and other operator selectable parameters. Using built in buttons; operators shall be able to adjust setpoints directly from the sensor.
5. Duct temperature sensors shall incorporate a thermistor bead embedded at the tip of a stainless steel tube. Probe style duct sensors are useable in air handling applications where the coil or duct area is less than 14 square feet.
6. Averaging sensors shall be employed in ducts, which are larger than 14 square feet. The averaging sensor tube must contain at least one thermistor for every 3 feet, with a minimum tube length of 12 feet.
7. Immersion sensors shall be employed for measurement of temperature in all chilled and hot water applications as well as refrigerant applications. Thermal wells shall be brass or stainless steel for non-corrosive fluids below 250 degrees F. and 300 series stainless steel for all other applications.
8. A pneumatic signal shall not be allowed for sensing temperature.

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B. Humidity Sensors

1. Humidity devices shall be accurate to +/- 5% at full scale for space and +/- 3% for duct and outside air applications. Suppliers shall be able to demonstrate that accuracy is NIST traceable.
2. Provide a hand held field calibration tool that both reads the output of the sensor and contains a reference sensor for ongoing calibration.

C. Pressure Sensors

1. Air pressure measurements in the range of 0 to 10" water column will be accurate to +/- 1% using a solid-state sensing element. Acceptable manufacturers include Modus Instruments and Mamac.
2. Differential pressure measurements of liquids or gases shall be accurate to +/- 0.5% of range. The housing shall be NEMA 4 rated.

D. Current and KW Sensors

1. Current status switches shall be used to monitor fans, pumps, motors and electrical loads. Current switches shall be available in solid and split core models, and offer either a digital or an analog signal to the automation system. Acceptable manufacturer is Veris or approved equal.
2. Measurement of three-phase power shall be accomplished with a kW/kWH transducer. This device shall utilize direct current transformer inputs to calculate the instantaneous value (kW) and a pulsed output proportional to the energy usage (kWH). Provide Veris Model 6000 Power Transducer or approved equal.

E. Flow Sensors

1. Provide an insertion vortex flow meter for measurement of liquid or gas flows in pipe sizes above 3 inches.
2. Install the flow meter on an isolation valve to permit removal without process shutdown.
3. Sensors shall be manufactured by EMCO or approved equal.

F. Carbon Dioxide Sensors

1. Non-Dispersive Infrared (NDIR), 0-2000 PPM.
2. Power Requirement, 18-30 VDC.
3. Voltage output, 0-10- VDC Full Scale.
4. Current output, 4-20 mA

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2.27 AIRFLOW MEASURING STATIONS

- A. Provide a thermal anemometer using instrument grade self heated thermistor sensors with thermistor temperature sensors. The flow station shall operate over a range of 0 to 5,000 feet/min with an accuracy of +/- 2% over 500 feet/min and +/- 10 ft/min for reading less than 500 feet/min.
- B. The output signal shall be linear with field selectable ranges including 0-5 VDC, 0-10VDC and 4-20 mA.
- C. Furnish Ebtron Series 3000 airflow stations or approved equal.

PART 3 – EXECUTION

3.1 GENERAL

- A. All DDC Controllers shall be networked to Central Communications controller.
- B. Existing Front-End Workstation in B & G office shall be configured for High School Addition access. Text/Graphic screens for each system shall match existing.
- C. Communications cabling shall be run in hallways above hung ceiling with plenum cable and wiremold where exposed.

3.2 CONTRACTOR RESPONSIBILITIES

- A. General: The Contractor or a Sub-Contractor shall perform installation of the building automation system. However, all installations shall be under the personal supervision of the Contractor. The Contractor shall certify all work as proper and complete.
- B. Demolition: Remove controls, which do not remain as part of the building automation system, all associated abandoned wiring and conduit and all associated pneumatic tubing. The Owner will inform the Contractor of any equipment, which is to be removed, that will remain the property of the Owner. The Contractor will dispose of all other equipment that is removed.
- C. Access to Site: Unless notified otherwise, entrance to building is restricted. No one will be permitted to enter the building unless their names have been cleared with the Owner or the Owner's representative.
- D. Code Compliance: All wiring shall be installed in accordance with all applicable electrical codes and will comply with equipment manufacturer's recommendations. Should any discrepancy be found between wiring Specifications in Division 26 and Division 22, wiring requirements of Division 26 will prevail for work specified in Division 26.

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- E. Cleanup: At the completion of the work, all equipment pertinent to this Contract shall be checked and thoroughly cleaned, and all other areas shall be cleaned around equipment provided under this Contract. Clean the exposed surfaces of tubing, hangers and other exposed metal of grease, plaster or other foreign materials.

3.3 WIRING, CONDUIT, TUBING AND CABLE

- A. All wire will be copper and meet the minimum wire size and insulation class listed below:

Wire Class	Wire Size	Isolation Class
Power	12 Gauge	600 Volt
Class One	14 Gauge Std.	600 Volt
Class Two	18 Gauge Std.	300 Volt
Class Three	18 Gauge Std.	300 volt
Communications	Per Mfr.	Per Mfr.

- B. Power and Class One wiring may be run in the same conduit. Class Two and Three wiring and communications wiring may be run in the same conduit.
- C. Where different wiring classes terminate within the same enclosure, maintain clearances and install barriers per the National Electric Code.
- D. Where wiring is required to be installed in conduit, EMT shall be used. Conduit shall be minimum 1/2 inch galvanized EMT. Setscrew fittings are acceptable for dry interior locations. Watertight compression fittings shall be used for exterior locations and interior locations subject to moisture. Provide conduit seal off fitting where exterior conduits enter the building or between areas of high temperature/moisture differential.
- E. Flexible metallic conduit (max. 3 feet) shall be used for connections to motors, actuators, controllers, and sensors mounted on vibration producing equipment. Liquid-tight flexible conduit shall be use in exterior locations and interior locations subject to moisture.
- F. Junction boxes shall be provided at all cable splices, equipment termination and transitions from EMT to flexible conduit. Interior dry location J-boxes shall be galvanized pressed steel, nominal four-inch square with blank cover. Exterior and damp location JH-boxes shall be cast alloy FS boxes with threaded hubs and gasket covers.
- G. Where the space above the ceiling is a supply or return air plenum, the wiring shall be plenum rated. Teflon wiring can be run without conduit above suspended ceilings. EXCEPTION: Any wire run in suspended ceilings that is used to control outside air dampers or to connect the system to the fire management system shall be in conduit.
- H. Coaxial cable shall conform to RG62 or RG59 rating. Provide plenum rated coaxial cable when running in return air plenums.

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- I. Fiber optic cable shall include the following sizes; 50/125, 62.5/125 or 100/140. Only glass fiber is acceptable, no plastic.
- J. Fiber optic cable shall only be installed and terminated by an experienced contractor. The BAS contractor shall submit to the Engineer the name of the intended contractor of the fiber optic cable with his submittal documents.

3.4 HARDWARE INSTALLATION

A. Installation Practices for Wiring and Tubing

- 1. All controllers are to be mounted vertically and per the manufacturer's installation documentation.
- 2. The 120VAC power wiring to each Ethernet or Remote Site controller shall be a dedicated run, with a separate breaker. Each run will include a separate hot, neutral and ground wire. The ground wire will terminate at the breaker panel ground. This circuit will not feed any other circuit or device.
- 3. A true earth ground must be available in the building. Do not use a corroded or galvanized pipe, or structural steel.
- 4. Wires are to be attached to the building proper at regular intervals such that wiring does not drop. Wires are not to be affixed to or supported by pipes, conduit, etc.
- 5. Conduit in finished areas will be concealed in ceiling cavity spaces, plenums, and furred spaces and wall construction. Exception; metallic surface raceway may be used in finished areas on masonry walls. All surface raceway in finished areas must be color matched to the existing finish within the limitations of standard manufactured colors.
- 6. Conduit, in non-finished areas where possible, will be concealed in ceiling cavity spaces, plenums, furred spaces and wall construction. Exposed conduit will run parallel to or at right angles to the building structure.
- 7. Wires are to be kept a minimum of three (3) inches from hot water or condense piping.
- 8. Where sensor wires leave the conduit system, they are to be protected by a plastic insert.
- 9. Wire will not be allowed to run across telephone equipment areas.

B. Installation Practices for Field Devices

- 1. Well-mounted sensors will include thermal conducting compound within the well to insure good heat transfer to the sensor.
- 2. Actuators will be firmly mounted to give positive movement and linkage will be adjusted to give smooth continuous movement throughout 100 percent of the stroke.
- 3. Relay outputs will include transient suppression across all coils. Suppression devices shall limit transients to 150% of the rated coil voltage.

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4. Water line mounted sensors shall be removable without shutting down the system in which they are installed.
5. For duct static pressure sensors, the high-pressure port shall be connected to a metal static pressure probe inserted into the duct pointing upstream. The low-pressure port shall be left open to the plenum area at the point that the high-pressure port is tapped into the ductwork.
6. For building static pressure sensors, the high-pressure port shall be inserted into the space via a metal tube. Pipe the low-pressure port to the outside of the building.

C. Enclosures

1. For all I/O requiring field interface devices, these devices, where practical, will be mounted in a field interface panel (FIP). The Contractor shall provide an enclosure, which protects the device(s) from dust, moisture, conceals integral wiring and moving parts.
2. FIP's shall contain power supplies for sensors, interface relays and Contractors, safety circuits, and I/P transducers.
3. The FIP enclosure shall be of steel construction with baked enamel finish; NEMA 1 rated with a hinged door and keyed lock. The enclosure will be sized for 20% spare mounting space. All locks will be keyed identically.
4. All wiring to and from the FIP will be to screw type terminals. Analog or communications wiring may use the FIP as a raceway without terminating. The use of wire nuts within the FIP is prohibited.
5. All outside mounted enclosures shall meet the NEMA-4 rating.
6. The tubing and wiring within all enclosures shall be run in plastic track. Wiring within controllers shall be wrapped and secured.

D. Identification

1. Identify all control wires with labeling tape or sleeves using either words, letters, or numbers that can be exactly cross-referenced with As-Built Drawings.
2. Identify all pneumatic tubing with labeling tape or sleeves using either words, letters, or numbers that can be exactly cross-referenced with As-Built Drawings.
3. All field enclosures, other than controllers, shall be identified with a Bakelite nameplate. The lettering shall be in white against a black or blue background.
4. Junction box covers will be marked to indicate that they are a part of the BAS system.
5. All I/O field devices (except space sensors) that are not mounted within FIP's shall be identified with nameplates.
6. All I/O field devices inside FIP's shall be labeled.

E. Control System Switch-Over

1. Demolition of the existing control system will occur after the new temperature control system is in place including new sensors and new field interface devices.

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2. Switch over from the existing control system to the new system will be fully coordinated with the Owner. A representative of the Owner will be on site during switch over.
3. The Contractor shall minimize control system downtime during switch over. Sufficient installation mechanics will be on site so that the entire switch over can be accomplished in a reasonable time frame.

F. Location

1. The location of sensors is per Mechanical and Architectural Drawings.
2. Outdoor air sensors will be mounted on the north building face directly in the outside air. Install these sensors such that the effects of heat radiated from the building or sunlight is minimized.
3. Field enclosures shall be located immediately adjacent to the controller panel(s) to which it is being interfaced.

3.5 SOFTWARE INSTALLATION

- A. General: The Contractor shall provide all labor necessary to install, initialize, start-up and debug all system software as described in this section. This includes any operating system software or other third-party software necessary for successful operation of the system.
- B. Database Configuration: The Contractor will provide all labor to configure those portions of the database that are required by the points list and sequence of operation.
- C. Color Graphic Slides: Unless otherwise directed by the Owner, the Contractor will provide color graphic displays as depicted in the Mechanical Drawings for each system and floor plan. For each system or floor plan, the display shall contain the associated points identified in the point list and allow for set point changes as required by the Owner.
- D. Reports - The Contractor will configure a minimum of 6 reports for the Owner as listed below:
1. Central Plant Status Report
 2. Air Handler Status Report
 3. Energy Consumption Report
 4. Space Temperature Report
 5. Specialty Equipment Status Report
- E. Documentation - As-Built software documentation will include the following:
1. Descriptive point lists
 2. Application program listing
 3. Application programs with comments

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4. Printouts of all reports
5. Alarm list
6. Printouts of all graphics

3.6 COMMISSIONING AND SYSTEM STARTUP

- A. Point-to-Point Checkout: Each I/O device (both field mounted as well as those located in FIP's) shall be inspected and verified for proper installation and functionality. A checkout sheet itemizing each device shall be filled out, dated and approved by the Project Manager for submission to the Owner or Owner's representative.
- B. Controller and Workstation Checkout: A field checkout of all controllers and front-end equipment (computers, printers, modems, etc.) shall be conducted to verify proper operation of both hardware and software. A checkout sheet itemizing each device and a description of the associated tests shall be prepared and submitted to the Owner or Owner's representative by the completion of the project.
- C. System Acceptance Testing
 1. All application software will be verified and compared against the sequences of operation. Control loops will be exercised by inducing a setpoint shift of at least 10% and observing whether the system successfully returns the process variable to setpoint. Record all test results and attach to the Test Results Sheet.
 2. Test each alarm in the system and validate that the system generates the appropriate alarm message, that the message appears at all prescribed destinations (workstations or printers), and that any other related actions occur as defined (i.e. graphic panels are invoked, reports are generated, etc.). Submit a Test Results Sheet to the Owner.
 3. Perform an operational test of each unique graphic display and report to verify that the item exists, that the appearance and content are correct, and that any special features work as intended. Submit a Test Results Sheet to the Owner.
 4. Perform an operational test of each third party interface that has been included as part of the automation system. Verify that all points are properly polled, that alarms have been configured, and that any associated graphics and reports have been completed. If the interface involves a file transfer over Ethernet, test any logic that controls the transmission of the file, and verify the content of the specified information.

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3.7 SEQUENCES OF OPERATION

A. Chiller with Associated Pumps and Appurtenances

1. Point List

- a. CHW Supply Temperature
- b. CHW Return Temperature
- c. Outside Air Temperature
- d. Chiller Start/Stop (2)
- e. Chiller Isolation Valve (4)
- f. Chiller Water Primary Pump Start/Stop/Status (2)
- g. Chilled Water Differential Pressure
- h. Chiller Capacity (2)
- i. Chiller Alarm (2)
- j. Chiller KW (2)
- k. Flow through Chiller (2)
- l. Chiller Status (2)

2. Sequence of Operation

- a. This system will consist of two outdoor air-cooled scroll chillers with two chilled water pumps.
- b. When the building is in the occupied mode of operation and the outside air is above 58 degrees F. (adjustable), the chilled water system will be activated in the following order.
- c. First, the lead chiller's chilled water valve will open, when this valve end switch proves that the valve is open the lead primary chilled water pump will start. After a 30 second time delay, if flow is proven by the chilled water flow switch, then the lead chiller will start. If one chiller is not capable of maintaining the desired chilled water temperature, then another chiller will be started in the following order.
- d. First, the lag chiller's chilled water valve will open. When this valve's end switch proves that the valve is open, the lag chilled water pump shall start, then the lag chiller will be started if its flow switch proves flow.
- e. When the demand for chilled water is reduced, or the system is switched to unoccupied the pumps and chillers will be shut down in reverse order. During chiller shutdown mode the chiller will be shut down first, then after a 90 second time delay the primary chilled water pumps will sequence off.

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- f. If one or more Chillers need to be isolated from the system, the automatic shut-off valves will be activated on the inlet and outlet of each module to disconnect it from the system.
- g. Chilled Water Differential Controller
- h. A software lead/lag switch will once weekly switch the primary pumps, and chillers (only when the system is off and in unoccupied mode).

3.8 CONTROL DIAGRAMS

- A. Complete new control diagrams showing type of apparatus, cycles of operation and details of all equipment must be submitted for checking and be approved before installation is started.
- B. Submit three (3) preliminary copies of the control diagrams, sequence descriptions, and equipment shop drawings for checking and submit six (6) copies, complete for final approval.
- C. At the completion of installation, control manufacturer shall furnish non-fading original; plastic laminated copies of all control diagrams as they apply to the particular instruments thereon. One complete set of non-fading plastic laminated diagrams shall be mounted on wall as directed.

3.9 CERTIFICATION

- A. After completion of installation and after equipment has been placed on operation, the temperature control manufacturer shall submit in writing, a complete and detailed report and certification that the entire installation is operating exactly as specified and shall be guaranteed for one year. Report shall state temperature and throttling range readings and settings of all control instruments. Submit to the Engineer preliminary for checking and approval.

3.10 INSTALLATION

- A. All work under the automatic temperature control Sub-Contract shall be done by competent skilled mechanics regularly in the employ of the temperature control manufacturer.
- B. Bidder must be a control manufacturer currently involved in the production of commercial pneumatic/electric temperature controls. Franchises and associations are not considered control manufacturers.

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3.11 TRAINING

- A. The Contractor shall supply personnel to train key customer personnel in the operation and maintenance of the installed system. The training program shall be designed to provide a comprehensive understanding and basic level of competence with the system. It shall be sufficiently detailed to allow customer personnel to operate the system independent of any outside assistance. On-line context sensitive HELP screens shall be incorporated into the system to further facilitate training and operation.
- B. The training plan shall include detailed session outlines and related reference materials. The customer personnel shall be able to utilize these materials in the subsequent training of their co-workers.
 - 1. Training time shall not be less than a total of 40 hours, and shall consist of:
 - a. 16 hours during normal day shift periods for system operators. Specific schedules shall be established at the convenience of the customer.
 - b. 24 hours of system training shall be provided to customer supervisory personnel so that they are familiar with system operation.
 - c. The specified training schedule shall be coordinated with the customer and will follow the training outline submitted by the Contractor as part of the submittal process.
 - d. Provide an as built Video training tape, showing and explaining all animated graphics in detail, all controllers and equipment the FMS operates (Four (4) Copies shall be supplied).
 - e. If further training is needed, the Contractor shall provide another 40 hours at no extra cost.
 - 2. All training sessions shall be scheduled by the Construction Manager. The Contractor shall provide sign-in sheets and distribute minutes of each session prior to the subsequent session. This documentation shall be included in the Operation and Maintenance manuals.

END OF SECTION 230460