SECTION 23 09 23.2

ENERGY MANAGEMENT CONTROL SYSTEM (Siemens)

PART 1 GENERAL

1.1 PURPOSE

A. This specification section is to be reviewed by the engineer and a review meeting will occur prior to issuing the bid documents. This specification should not be modified unless approved by UTA. This specification is to provide UTA with a system that seamlessly integrates with our current EMS. The system will be manufactured by Siemens and use the current version of the Disego CC platform.

1.2 LESSONS LEARNED AND DESIGN CONSIDERATIONS

A. A separate controls schedule should be required by the controls installer and reviewed weekly at the commissioning meeting or OAC meeting.

B. Lead-Lag requirements will be reviewed by the manufacturer's representative and recommendations given for durations of equipment operation. How long should each piece of equipment be exercised.

C. Equipment representatives should review control sequences and provide comments prior to controls contractor installing and programming controls. This will ensure the operation is not in conflict with the proper operation of the equipment.

D. The controls contractor will request any information/IP addresses etc. from UTA as soon as possible but prior to controls contractor installing equipment. This should also be an item on the Cx meeting agenda until all requests have been closed out.

E. Ensure all control devices in the occupied spaces have been reviewed for mounting requirements. Items like accessibility, possible damage and surface type should be reviewed prior to installation.

F. TAB contractor should have an onsite meeting with the controls contractor and mechanical subcontractor to discuss locations of sensors and test plug connections prior to TAB contractor onsite work.

G. If selected control valves are less than one pipe size less than the main pipe size the pressure drop through the valve and reducers must be reviewed by the engineer and approved.

H. Temperature sensors/operators will not be adjustable by occupants or have a display in common areas unless directed by UTA. The Siemens QMX series of temperature sensors/operators will be used as a standard in the building.

I. During the design process any skid mounted equipment packages will have in writing what points can and will be monitored by the EMCS. UTA will require the control system to be able to change set points through the EMCS and not solely at the local control panel.

J. Lab controls will be Phoenix Controls and will be incorporated into the existing Phoenix control system that is linked through the building control system. See specification 23 09 23.3.

1.1 WORKDESCRIPTION

A. Scope: This section contains general requirements for the supply and installation of a microprocessor based Energy Management System (EMS) as an extension to the existing UTA Campus Siemens Building Technologies System 600 APOGEE□.

B. Siemens shall be responsible for furnishing and installing all equipment and wiring for Building Automation Systems (Temperature and HVAC Equipment Control) for a complete and operable system as specified herein. All wiring shall be done in accordance with all local and national codes.

C. Work Included: It is the intent of this specification for the EMS to be installed as a complete package by Siemens Building Technologies. The system shall include all computer software and hardware, controllers, sensors, transmission equipment, local panels, installation, engineering, supervision, commissioning, acceptance test, training, and warranty service.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Products connect to the EMS but not furnished or installed under this section include AHU air flow stations, AHU automatic dampers, valves, flow switches, flow sensors, thermowells and pressure taps to be installed by the Division 23 and/or 26.

1.	Section 23 06 20.13	Hydronic Specialties
2.	Section 23 29 23	Variable Frequency Drives
3.	Section 23 36 00	Air Terminal Unit (VAV)
4.	Section 23 73 23	Air Handling Units

B. Coordination with electrical:
1. Installation of all line voltage power wiring including 120V power to each terminal unit and DDC panel by Division26.
2. Each motor starter provided under Division 23 or 26, shall be furnished with individual control power transformer to supply 120 volt control power and auxiliary contacts (one N.O. and one N.C.) for use by this section.

1.3 QUALIFICATIONS

A. System components shall be provided by Siemens Building Technologies.

B. The control system shall be furnished, engineered and installed by a Siemens owned branch office having factory trained technicians to provide instruction, routine maintenance, and emergency service within 24 hours upon receipt of request.

C. The control system components shall be new and in conformance with the following applicable standards for products specified:
1. American Society for Testing and Materials, ASTM
2. Institute of Electrical and Electronic Engineers, IEEE
3. National Electrical Manufacturers Association, NEMA
4. Underwriters Laboratory, UL (UL 916 & 864)
5. FCC Regulation, Part 15, Section 156
6. National Fire Protection Association, NFPA
7. Local Building Codes

1.4 SUBMITTALS

A. The controls contractor shall submit AutoCAD generated schematic drawings for the entire system for review and approval before work shall begin. Included in the submittal drawings shall be a one page diagram depicting the system architecture complete with a communications riser. Drawings shall include point-to-point wiring diagrams and any special connection information required for properly controlling the equipment. The submittal shall include a bill of material reference list as well as equipment sequences of operation.

B. The submittals shall include the manufacturer's catalog data describing, highlighting and specifically indicating each item of equipment or component provided and installed for the project.

1.5 PROTECTION OF SOFTWARE RIGHTS

A. Prior to delivery of software, the Owner and the party providing the software will enter into a software license agreement with provisions for the following:
1. Limiting use of software to equipment provided under these specifications.
2. Limiting copying.
3. Preserving confidentiality.
4. Prohibiting transfer to a third party.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Siemens Building Technologies is the only acceptable manufacturer/installer.

2.2 NETWORKING

A. The design of the EMS shall network operator workstations and stand-alone DDC Controllers. The network architecture shall consist of three levels, a campus-wide (Management Level Network - MLN) Ethernet network based on TCP/IP protocol, high performance peer-to-peer

Automation Level Network (ALN) and Application Specific Controller Field Level Networks (FLN) with access being totally transparent to the user when accessing data or developing control programs.

B. The owner shall provide a point of connection for each ALN level controllers to the campus Ethernet backbone for a campus-wide System 600 Management Level Network.

C. The design of the EMS shall allow the co-existence of new DDC Controllers with existing DDC Controllers in the same network without the use of gateways or protocol converters.

D. All operator devices either network resident or connected via dial-up modems shall have the ability to access all point status and application report data or execute control functions for any and all other devices via the peer-to-peer network. No hardware or software limits shall be imposed on the number of devices with global access to the network data at any time.

E. A single Workstation shall support a minimum of four (4) Automation Level Networks (ALN).

The ALN's can be any combination of direct or modem connected Networks. All Networks shall be dynamically connected to allow access to points on different ALN's simultaneously.

2.3 DDC CONTROLLERS

A. DDC Controllers shall be shall be stand-alone, multi-tasking, multi-user, real-time digital control processors with a minimum word size of 16 bits, minimum 48MHz clock and minimum 12MB memory consisting of modular hardware with plug-in enclosed processors, communication controllers, power supplies and input/output point modules (universal or discrete). Each major DDC Controller (PXC Modular) shall support a minimum of 96 FLN Devices.

B. Each DDC Controller shall support its own operating system and databases, including:
1. Control processes.
2. Energy management applications.
3. Alarm management applications including custom alarm messages for each level alarm for each point in the system.
4. Historical/trend data for points specified.
5. Maintenance support applications.
6. Custom processes,
7. Operator I/O.
8. Dial-up communications.
9. Manual override monitoring.

C. Each DDC Controller shall support any combination of industry standard inputs and outputs.

D. Provide all processors, power supplies and communication controllers so that the implementation of a point only requires the addition of the appropriate point input/output termination module and wiring.

E. DDC Controllers shall be provided with one RS-232C serial data communication port for the portable laptop operator's terminal. When a modem is required for remote operation, a second RS-232C serial data communication port shall be provided. DDC Controllers shall allow

temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers or terminals.

F. The operator shall have the ability to manually override automatic or centrally executed commands at the DDC Controller via local, point discrete, on-board hand/off/auto operator override switches for digital control type points and gradual switches for analog control type points.
1. Switches shall be mounted within the DDC Controller's key-accessed enclosure.
2. DDC Controllers shall monitor the status of all overrides and inform the operator that automatic control has been inhibited. DDC Controllers shall also collect override activity information for reports.

G. DDC Controllers shall provide local LED status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device. Graduated intensity LED's for analog indication of value shall also be provided for each analog output. Status indication shall be visible without opening the panel door (MBC only).

H. Each DDC Controller shall continuously perform self-diagnosis, communication diagnosis and diagnosis of all panel components. The DDC Controller shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication.

I. Isolation shall be provided at all peer-to-peer network terminations, as well as all field point terminations to suppress induced voltage transients consistent with IEEE Standards 587-1980.

J. In the event of loss of all power, there shall be an orderly shutdown of all DDC Controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 100 hours.
   1. Upon restoration of normal power, the DDC Controller shall automatically resume full operation without manual intervention.
   2. Should DDC Controller memory be lost for any reason, the user shall have the capability of reloading the DDC Controller via the local RS-232C port, via telephone line dial-in or automatically from the network workstation PC.

K. As a minimum, a separate DDC Controller shall be provided for each mechanical room.

2.4 DDC CONTROLLER RESIDENT SOFTWARE

A. General:
   1. The software programs specified in this Section shall be provided as an integral part of DDC Controllers and shall not be dependent upon any higher level computer for execution.

B. Control Software Description:
   1. The DDC Controllers shall have the ability to perform the following pre-tested control algorithms:
      a. Two-position control
      b. Proportional control
      c. Proportional plus integral control
      d. Proportional, integral, plus derivative control
      e. Automatic tuning of control loops

C. DDC Controllers shall have the ability to perform any or all the following energy management routines:
   1. Time-of-day scheduling
   2. Calendar-based scheduling
   3. Holiday scheduling
   4. Temporary schedule overrides
   5. Start-Stop Time Optimization
   6. Automatic Daylight Savings Time Switchover
   7. Night setback control
   8. Enthalpy switchover (economizer)
   9. Peak demand limiting
   10. Temperature-compensated duty cycling

D. DDC Controllers shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.
   1. A single process shall be able to incorporate measured or calculated data from any and all other DDC Controllers on the network. In addition, a single process shall be able to issue commands to points in any and all other DDC Controllers on the network.
   2. Processes shall be able to generate operator messages and advisories to operator I/O devices. A process shall be able to directly send a message to a specified device or

cause the execution of a dial-up connection to a remote device such as a printer or pager.

E. Alarm management shall be provided to monitor and direct alarm information to operator devices. Each DDC Controller shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic and prevent alarms from being lost. At no time shall the DDC Controllers ability to report alarms be affected by either operator or activity at a PC workstation, local I/O device or communications with other panels on the network.

1. All alarm or point change reports shall include the point's English language description and the time and date of occurrence.
2. The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of six priority levels shall be provided for each point. Point priority levels shall be combined with user definable destination categories (PC, printer, DDC Controller, etc.) to provide full flexibility in defining the handling of system alarms. Each DDC Controller shall automatically inhibit the reporting of selected alarms during system shutdown and start-up. Users shall have the ability to manually inhibit alarm reporting for each point.
3. Alarm reports and messages will be directed to a user-defined list of operator devices or PCs.
4. In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 200 character alarm message to more fully describe the alarm condition or direct operator response.
5. In dial-up applications, operator-selected alarms shall initiate a call to a remote operator device.

F. A variety of historical data collection utilities shall be provided to manually or automatically sample, store and display system data for points as specified in the I/O summary.

1. Any point, physical or calculated may be designated for trending. Any point, regardless of physical location in the network, may be collected and stored in each DDC Controllers point group. Two methods of collection shall be allowed: either by a pre-defined time interval or upon a pre-defined change of value. Sample intervals of l minute to 7 days shall be provided. Each DDC Controller shall have a dedicated RAM-based buffer for trend data. All trend data shall be available for use in 3rd party personal computer applications such as Excel 5.0.
2. DDC Controllers shall also provide high resolution sampling capability for verification of control loop performance. Operator-initiated automatic and manual loop tuning algorithms shall be provided for operator-selected PID control loops as identified in the point I/O summary.
    a. Loop tuning shall be capable of being initiated either locally at the DDC Controller, from a network workstation or remotely using dial-in modems. For all loop-tuning functions, access shall be limited to authorized personnel through password protection.

G. DDC Controllers shall automatically accumulate and store run-time hours for digital input and output points and automatically sample, calculate and store consumption totals for analog and digital pulse input type points, as specified in the point I/O summary.

H. DDC Controllers shall be password protected. The user’s Password and Privileges shall be identical to the Password and Privileges used at the EMS Workstation.

2.5 APPLICATION SPECIFIC CONTROLLERS

A. Terminal Equipment Controllers (TEC)

1. Provide for control of each piece of equipment, including, but not limited to, the following:

a. VAV with or without heating coils
b. All fan coil units except those fan coil units specifically dedicated to each residence rooms. All fan coil units serving common areas (electrical rooms, MDF, IDF, classrooms, offices, corridors, etc.) will receive a controller from the controls contractor. Residence room fan coils will be stand alone control by equipment manufacturer. Mechanical contractor should route thermostat wiring between t- stat and fan coil within each residence room.

2. The controllers shall include all inputs and outputs necessary to perform the specified control sequences. Analog outputs shall be 24 volt floating.
3. Each controller performing space temperature control shall be provided with a matching room temperature sensor with a setpoint adjustment between 55 □F and 95 □F.
4. Any piece of equipment with either a hot water and/or chilled water coil shall be provided with a supply air temperature sensor.
5. Each room temperature sensor shall include a terminal jack integral to the sensor assembly. The terminal jack shall be used to connect a portable operator's terminal to control and monitor all hardware and software points associated with the respective controller.
6. Setpoint adjustment and override function shall have the ability to be locked out, overridden, or limited as to time or temperature through software by an authorized operator at the central workstations, at the DDC Controller, or via the portable operator's terminal.
7. Each controller shall perform its primary control function independent of the DDC Controller. The controller shall receive its real-time data from the DDC Controller time clock. Each controller shall include algorithms incorporating proportional, integral, and derivative (PID) gains for all applications. All PID gains and biases shall be adjustable by the user via terminals as specified herein.
8. Provide each terminal equipment controller with sufficient memory to accommodate point databases and operating programs. All databases and programs shall be stored in non-volatile EEPROM, EPROM, and PROM. The controllers shall be able to return to full normal operation without user intervention after a power failure. Operating programs shall be selectable and may be modified to meet the user's exact control strategy requirements, allowing for additional system flexibility.
9. Controllers shall be powered from a 24 VAC source, and shall function normally under an operating range of 18 to 28 VAC (-25% to +17%), allowing for power source fluctuations and voltage drops. The controllers shall also function normally under ambient conditions of 32 Degrees to 122 Degree F and 10-95% RH (non-condensing). Provide each controller with a suitable cover or enclosure to protect the intelligence board assembly.
10. Pressure independent controllers shall include differential pressure transducers that shall connect to the terminal unit manufacturer's standard averaging air velocity sensor to measure the average differential pressure in the duct. The controller shall convert this value to actual airflow. The differential pressure transducer shall have a measurement range of 400 to 4,000 FMP and measurement accuracy of +/-5% at 400 FPM ensuring primary air flow condition shall be controlled and maintained to within +/-5% of setpoint at the specified parameters. Each controller shall include provisions for manual and automatic calibration of the differential pressure transducer in order to maintain stable control and ensuring against drift overtime. The controller requiring 24 hours a day operation shall calibrate the airflow sensor every 24 hours with the use of an auto-zero module to eliminate the requirement of closing the supply damper to calibrate the flow sensor. It shall not be necessary to remove the controller to remove the damper actuator.

2.6 VALVES, DAMPERS AND ACTUATORS

A. Valves

1. Water valves shall be sized by the control manufacturer to produce the required capacity at a pressure loss of 5 psi. Nominal body rating shall be not less than ANSI Class 125. However, the valve body and packing selected shall be designed to withstand the system static head plus the maximum pump head and the maximum temperature of control medium. Single-seated valves shall have close-off ratings equal to 125% of the system pressure encountered that is the maximum upstream pressure. The valve body and packing selected shall be designed to withstand the system static head plus the maximum pump head and the maximum temperature of control medium without leakage for hot water.
2. Two-Way and Three-Way Valves:
   a. Valves used for control of hot and chilled water shall be of the modulating globe type.
   b. Valve sizes two inch and smaller shall be screwed and supplied with union fittings. The valves shall be constructed of bronze with stainless steel trim with equal

      percentage flow characteristics and have a rangeability of 50:1 or greater.
   c. Valve sizes 2.5 inch and larger shall be flanged. The valves shall be constructed of cast iron ASTM A126 Class B. The trim shall be stainless steel with equal percentage flow characteristics. The valve rangeability shall be 100:1 or greater.
   d. Valves shall be of the straight-through type as required by the sequence or indicated on the drawings.
3. Butterfly Valves: Where butterfly valves are indicated to be used as automatic control valves, they shall be line size and designed for motorized control operation with upper disc steam keyed or machined square for mating with the control operators linkage. All butterfly control valves over 8 inches shall be equipped with a manual, mechanical control actuator override, gear box operator for emergency manual control of the valve position. Provide required accessories to mechanically disengage automatic control actuator linkage and engage manual gear operator without dismantling the valve stem and stem extensions during changeover. Valves 4-20" and larger shall be tapped, full lug, cast iron body butterfly valves with aluminum bronze discs, stainless steel stem and EPDM seat. Design must incorporate top and bottom bushings between shafts and body of material suitable to provide a bearing surface to eliminate seizing or galling. Valves 4-20" must provide bubble-tight seal at 150 PSIG. Liners are to be resilient material suitable for 250 Ftemperature.
4. Control valve sizing may not be less than one pipe size smaller than diameter of pipe.
5. Valve Constant (Cv) Charts: Control drawings shall indicate the valve constant (Cv rating) of all valves used so that the valve pressure drop may be used for balancing and performance tests. Submittal data shall also state calculated shut-off pressure for each valve size.

B. Dampers

1. The Temperature Control Manufacturer shall provide control dampers of the types and sizes indicated on the drawings, including but not limited to outside air, return, relief air dampers, isolation and exhaust system bypass dampers. This includes dampers inside AHU's and outside air units. Refer to schedules and details for that equipment to determine where controls dampers are specified.
2. Damper frames shall be 5" X 1" 6063T5 extruded aluminum hat channel with .125" minimum wall thickness with mounting holes for flange and enclosed duct mounting.
3. Dampers shall be available in two-inch size increments from 8" horizontal and vertical to 48". Requirements over 48" shall be standard modules with interconnecting hardware (jack shafting).
4. All damper blades shall be 6" 6063T5 heavy gage extruded aluminum airfoil for high velocity performance. Blades on all dampers must be not over 6" wide. Blade

bearing shall be molded synthetic with 1/2" hex plated steel shafts. All blade linkage hardware shall be of corrosion-resistant finish and readily accessible for maintenance after installation.

5. Extruded vinyl edging seals for outdoor dampers and flexible metal compressible type side seals for all dampers shall be provided.
6. Dampers and seals shall be suitable for temperature ranges of -50 Degrees F. to +250 Degrees F. at specified leakage ratings.
7. Dampers used for proportional control shall have opposed blades.
8. Leakage rates shall not exceed 6.25 CFM/Sq. Ft. at 4" wg. differential rated in accordance with AMCA 500.
9. Acceptable manufacturers are Ruskin, Arrow United Industries, American Warming and Ventilating, Inc. or approved equal.

C. Damper and Valve Actuators

1. Electronic actuators shall be of 0-10 VDC type. The minimum actuator impedance shall be 800 ohms even when more than one actuator is connected in parallel. Spring return shall be required for two-position (NO/NC) control sequence or for steam valve control. Non-spring return actuators shall be used for all modulating sequence of control. They shall conform to

   all requirements of sequence descriptions specified or scheduled. Main mechanical equipment actuators shall have a manual position dial to allow manual positioning of valve in absence of control power.
2. Valve actuators shall be of sufficient size to close valves at system pressure drop across the valve plus 50%.
3. Actuators for Terminal Equipment Controllers shall be 24V floating point, 0-10Vdc or pneumatic depending on Sequence of Operation and required speed of response. Regardless of actuator type, they shall be modulating and their position shall be readable in percentage open at the Workstation.

2.7 FLOW STATIONS

A. Duct Mounted Flow Station (Duct Velocities Greater than 700 FPM)

1. Provide where indicated on the plans airflow measuring stations capable of continuously measuring the air volume of the respective ductwork.
2. The airflow measuring station shall contain multiple total and static pressure sensors positioned in a log-Tchebycheff pattern. The airflow measuring stations shall be fabricated of a minimum of 14 ga. Galvanized steel, welded casing in 8” depth with 90º connecting flanges in a configuration and size equal to that of the duct it is mounted into.
3. The duct work airflow traverse probes (two per duct) shall have dual end support swivel brackets suitable for mounting in the fan inlet bell and symmetrical averaging signal takeoffs and fittings, and shall be of aluminum construction with hard anodized finish. Each station shall be complete with an open cell air straightner-equalizer honeycomb mechanically fastened to the casing, and external signal connection fittings. An identification label shall be placed on each station casing listing model number, size, area and specific airflow capacities.
4. The stations shall be AMCA certified and be capable of measuring the airflow rates within an accuracy of 2% of actual flow. The maximum allowable unrecovered pressure drop caused by the station shall not exceed .085” w.c. at 2000FPM.
5. The airflow measuring station shall be the FAN-Evaluator as manufactured by Air Monitor Corporation or approved equal.

B. Duct Mounted Flow Station (Duct Velocities Less than 700 FPM)

1. Provide a thermal dispersion airflow and temperature measurement device (ATMD) equipped with “C” sensor density probes for application requiring accurate

airflow measurement without field adjustment.

2. The typical accuracy of 3% of reading from 0-5000 FPM.
3. The ATMD includes an industrial grade integrating transmitter with independent field- configurable airflow outputs of 0-5 vdc, 0-10vdc and 4-20 ma for communication with the Building Automation System.
4. The ATMD shall be a EBTRON Gold Series GTA116-PC, Air Monitor ELECTRA-flo or approved equal.

C. Flow Stations on Fan Inlets

1. Provide on the indicated fans airflow traverse probes mounted in the fan inlets capable of continuously measuring the air volume of the respective fan.
2. The fan inlet airflow traverse probes shall contain multiple total and static pressure sensors placed at concentric area centers along the exterior surface of the cylindrical probe and internally connected to their respective averaging manifolds. Sensors shall not

   protrude beyond the surface of the probe, nor be adversely affected by particle contamination normally present in building system airflows.
3. The fan inlet airflow traverse probes shall have symmetrical averaging signal takeoffs and be of aluminum construction with hard anodized finish with galvanized mounting hardware.
4. The fan inlet traverse probes shall not significantly impact fan performance or contribute to fan generated noise levels. The probes shall capable of producing steady, non- pulsating signals of standard total and static pressure, without need for flow corrections or factors with an accuracy of 3% of actual flow over a fan operating range of 6 to 1 capacity turndown.
5. The fan inlet airflow traverse probes shall be the VOLU-probe FI as manufactured by Air Monitor Corporation or approved equal.

2.8 FIELD SENSORS

A. Temperature Sensors

1. The sensor shall be one of the following temperature sensor types:
   a. 1000 ohm (□ 0.2%) platinum resistance temperature detectors having a coefficient of resistivity of 0.00385 ohms/ohm/□ C (for animal room locations).
   b. 100 ohm (□ 0.12%) platinum resistance temperature detectors having a coefficient of resistivity of 0.00385 ohms/ohm/□ C. Provide RTD temperature transducers with of 4-20 ma output signal variations of less than 0.2% of full scale output for supply voltage variations +/-10% and integral and accessible zero and span adjustment.
   c. 10,000 ohm thermistor having an accuracy of .5□F at calibration point of 77□F may be used for room temperature only. Where applicable, the Room Temperature Sensor (RTS) shall share the wireless mesh technology FLN.
   d. Immersion temperature sensors shall have 316 Stainless Steel wells and duct mounted sensors shall use averaging bulbs of not less than 24" and when mounted in the preheat or mixed air position the averaging bulb shall be twice the diagonal length of the coil or duct.

B. Dewpoint Sensors

1. The sensor shall be a two-wire loop powered duct mounted relative humidity and temperature sensor having a measuring range 0 to 100% of R.H. with an accuracy no less than ±2.5%. The sensor will calculate dewpoint temperature between -20°C and 80°C. The output from the sensor shall be 4-20 ma. Dewpoint sensors shall be Vaisala HMT100 or equal.

C. Carbon Dioxide Sensor

1. The sensor shall be a duct mounted microprocessor- based photo-acoustic CO2 sensor to read CO2 levels in the return air. The sensor shall have a range of 0-2000 ppm with

an accuracy of 100 ppm. CO2 sensor shall be Siemens QPA63 Series or equal.

D. Pressure Sensors

1. The sensor shall be an air differential pressure transducers with output of 4-20 ma proportional to pressure. The airflow transmitter will have an accuracy of at least 0.5%
F.S for velocity pressure applications and 1.0% F.S for static pressure applications. Airflow transmitter shall be either Dresser Industries Ashcroft Model XLDp or Setra C264 Lab.

2. The sensor shall be a water or steam differential pressure transducers with output of 4-20 ma proportional to pressure. The transmitter will have an accuracy of at least 0.25% of the transmitter range. The pressure sensor shall have an LCD display. The transmitter shall be Siemens SITRAN 7MF4433 or 7MF4033 depending on the application or equal.

E. Smoke Detectors

1. Smoke sensors are provided and installed under Division 28 to conform to local codes.

F. Low Limit Temperature Switch

1. The sensor shall be for freeze protection with manual reset as specified hereinafter. Element shall be serpentine across the face of the coil and shall be of sufficient length or number for 1ft of sensing element for each sqft of duct or coil it is protecting. Connect Low Limit Temperature Switch in series with other safety devices to de-energize fans serviced when a drop in temperature below setpoint is detected.

G. Electronic-to-Pneumatic Transducers

1. E/P Transducers shall convert 0-10 Vdc or tri-state control to a 0-20 psig pneumatic output. The device shall have an output accuracy of 0.5 psi at 77 F and a repeatability of 0.05psig. Bleed rate shall not exceed 80 SCIM. The E/P shall utilize a "pump/dump" technology. The E/P Transducer shall have the ability to build or release a volume of no less than 500 SCIM.

H. Differential Pressure Switches

1. The sensor shall be a pressure switch to monitor the pressure drops across each piece of equipment specifically a filter banks, fans and pumps.
2. Design and sensitivity shall match application, with SPDT contacts to make/break from a field adjustable differential pressure setting for alarm reporting to the EMS. Switches utilized for filter banks and fans shall be Powers Static Pressure Air Flow Switches Series SW 141 or equal. Switches for pumps shall be Penn P74 differential pressure switch or equal.

I. Current Status Switch (CSS)

1. The sensor shall be a high performance miniature split-core current status switch with adjustable set point. The current status switch shall have an operating range of between
1.25 – 50 amps and be able to detect belt loss and mechanical failure. CSS shall be Veris Hawkeye H908 or equal.

J. Pressure Electric Switch (PE)

1. The sensor shall be a pressure operated snap switch that can actuate electrical circuits. The contact ratings shall be 8 amps at 240V inductive.

K. Chilled Water Flow Meter

1. Chilled and Heating Water Flow Meter: The flow meter shall measure the volumetric flow of chilled and/or heating water. The Flow Meter computer shall housed in a

NEMA 4X enclosure and display instantaneous and total flow.

a. Accuracy: ±1% of flow rate between ± 40 ft/sec.
b. Maximum operating pressure:- Not Applicable.
c. Operating Temperature:- 40ºF to +250ºF.
d. Acceptable Manufacture: Onicon electromagnetic type or equal.

L. Mineral Gas Flow Meter

1. Natural Gas Flow Meter: The flow meter shall measure natural gas volume in standard units without need for temperature or pressure compensation. It provides an isolated 4-
20 ma linear output for flow rate and an isolated 4-20 ma output for process gas temperature. The flow meter shall be insertion design and utilize a Constant Temperature Differential technology to provide a reliable and accurate signal. The flow meter shall have a 100:1 turndown ratio.

a. Accuracy: ±1% of reading ± 0.2% of full scale.
b. Maximum operating pressure:- 500 PSIG.
c. Operating Temperature:- 40ºF to +400ºF.
d. Acceptable Manufacture: Fox Thermal Instruments Inc. Model FT2 Gas and Temperature Transmitter or equal.

2.9 LOCAL CONTROL PANELS

A. Provide control panels with suitable brackets for wall mounting, for each miscellaneous control system. Locate panel adjacent to systems served.

B. Fabricate panels of 14-gauge furniture-grade steel, or 6063-T5 extruded aluminum alloy, totally enclosed, with hinged doors and keyed lock, with manufacturer's standard shop-painted finish and color. Provide UL listed cabinets for use with line voltage devices.

C. Panel Mounted Equipment: Include temperature controllers, relays, and other devices excluded in the sequence of operation. Mount devices with adjustments accessible through the fronts of panels.

2.10 PORTABLE SERVICE TOOL

A. No additional interface software shall be required.

PART 3 - EXECUTION

3.1 PROJECT MANAGEMENT

A. Provide a project manager who shall, as a part of his duties, be responsible for the following activities:

1. Coordination between this Contractor and all other trades, Owner, local authorities and the design team.
2. Scheduling of manpower, material delivery, equipment installation and checkout.
3. Maintenance of construction records such as project scheduling and manpower planning and Auto CAD for project coordination and as-built drawings.

3.2 INSTALLATION METHODS

A. Electrical Wiring

1. Install systems and materials in accordance with manufacturer's instructions, rough-in drawings and equipment details. Install electrical components and use electrical products complying with requirements of applicable Division 26 Sections of these Specifications except where specifically stated in this Section.

2. The term "control wiring" is defined to include providing of wire, conduit, and miscellaneous material as required for mounting and connecting electric or electronic control devices.
3. Install all control wiring in EMT conduit with compression fittings for electric/electronic control systems. Conceal wiring, except in mechanical rooms and areas where other conduit and piping are exposed. UL plenum rated cable shall be allowable above accessible lift out ceiling, in air plenums, and in other areas as approved by local and NEC codes.
4. Wall sensors shall be installed on electrical “J” boxes and conduit stubbed to above lift out ceilings. Plastic bushing shall be installed where the sensor wire exits the conduit to prevent damage.
5. Number-code or color-code conductors, excluding those used for individual zone controls, appropriately for future identification and servicing of control system.
6. This section shall provide all line voltage power wiring required because of substitution of equipment specified in this section.
7. Division 26 shall provide 120 volt power to all DDC Controllers specified in paragraph 2.3 of this Section.
8. Install all control wiring in galvanized rigid conduit and seal tight flex connectors where run outside the building structure or install in wetareas.

3.3 SYSTEMACCEPTANCE

A. General: The system installation shall be complete and tested for proper operation prior to acceptance testing for the Owner's authorized representative. A letter shall be submitted to the Architect requesting system acceptance. This letter shall certify all controls are installed and the software programs have been completely exercised for proper equipment operation. Acceptance testing will commence at a mutually agreeable time within ten (10) calendar days of request. When the field test procedures have been demonstrated to the Owner's representative, the system will be accepted. The warranty period will start at this time.

B. Field Equipment Test Procedures: DDC control panels shall be demonstrated via a functional end-to-end test. Such that:
   1. All output channels shall be commanded (on/off, stop/start, adjust, etc.) and their operation verified.
   2. All analog input channels shall be verified for properoperation.
   3. Changing the state of the field device and observing the appropriate change of displayed value shall verify all digital input channels.
   4. If a point should fail testing, perform necessary repair action and retest failed point and all interlocked points.
   5. Introducing an error into the system and observing the proper corrective system response shall verify automatic control operation.
   6. Changing the schedule and observing the correct response on the controlled outputs shall verify selected time and setpoint schedules.

C. Record Documentation: After a successful acceptance demonstration, the Contractor shall submit as-built drawings of the completed project for final approval. After receiving final approval, supply 6 copies of complete 11 x 17 as-built drawings sets and one (1) CD of ACAD drawings.

D. Operation and Maintenance Manuals: Submit three copies of operation and maintenance manuals. Include the following:
   1. Manufacturer's catalog data and specifications on sensors, transmitters, controllers, control valves, damper actuators, gauges, indicators, terminals and any miscellaneous components used in the system.
   2. An operator's manual that will include detailed instructions for all operations of the system.
   3. An operator's reference table listing the addresses of all connected input points and output points. Settings shall be shown whereapplicable.

4. A programmer's manual that will include all information necessary to perform programming functions.
5. A language manual that will include a detailed description of the language used and all routines used by thesystem.
6. Complete program listing file and parameter listing file for all programs.
7. A copy of the warranty.
8. Operating and maintenance cautions and instructions.
9. Recommended spare parts list.

3.4 TRAINING

A. Contractor shall provide to the engineer a training class outline prior to any scheduled training.

B. Factory trained control engineers and technicians shall provide training sessions for the Owner’s personnel.

C. The control contractor shall conduct five six-hour training sessions on the DDC System for the designated Owner's personnel in the maintenance and operation of the Systems. The class shall be given upon system acceptance.

D. The course shall include instruction on specific systems and instructions for operating the installed system to include as a minimum:
1. HVAC system overview.
2. Operation DDC Systems.
3. Function of each Component.
4. System Operating Procedures.
5. Programming Procedures.
6. Maintenance Procedures.

3.5 SERVICE AND GUARANTEE

A. This system specified under this Section of the Specifications shall be guaranteed from defects in workmanship and material under normal use and service for a period of twelve (12) months from the date of acceptance. If, during the one year period, any of the factory equipment or materials provided in the system is found to be defective in materials or workmanship, it shall be replaced or repaired by the DDC Manufacturer at no additional cost to the Owner.

B. Upon completion of the installation, the Contractor shall thoroughly inspect, check, adjust, calibrate, and make ready for use all devices/sensors comprising the control system and certify that they are installed in accordance with "Record"Drawings.

END OF SECTION 23 09 23.2