TOPEKA METRO

REQUEST FOR BIDS
QSS HVAC Controls
TO-25-02

Appendix 1
Engineer's Written Specifications

SECTION 239575 - AUTOMATIC TEMPERATURE CONTROLS - DDC

1. PART 1 - GENERAL

1.1. RELATED DOCUMENTS

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

1.2. SUMMARY

This Section includes control equipment for building energy consuming systems such as HVAC systems plus control components for terminal heating and cooling units that are not supplied with factory-wired controls.

1.3. SYSTEM DESCRIPTION

Furnish and install a DDC temperature control and energy management system (EMS) of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multitasking, multiuser environment on token-passing network and programmed to operate mechanical systems according to descriptions of operation indicated or specified.

The system shall have open protocol to facilitate interfacing by other manufacturers.

The system shall be of DDC controls that are going to be furnished for install Air Handling units. The system shall communicate to the RTU controls via BACnet Master-Slave-Token-Passing (MS/TP) protocol. All applicable data will be imported into the overall DDC system from the RTU's.

The Direct Digital Control System shall be comprised of a network of various independent, stand-alone controllers, mechanical system controllers, Air Handler controller, unitary controllers, lighting interface controllers, Variable Air Volume controller; together with central control workstations, portable operator terminals, and telephone interface, as specified, to provide centralized access and facility wide control functions. The individual devices shall be interconnected in a communicating network to provide facility wide access and sharing of information. A Local Area Network (LAN) shall be provided to interconnect devices for high-speed data transmission.

Furnish and install a complete control system. The system shall be complete in all respects including labor, material, equipment, and services necessary. All automation and control components shall be integrated into a distributed network system communicating over a nonproprietary local area network. The system shall consist of the following:

Application Specific Controllers

Direct Digital Control Panels

Desktop operators workstation (graphic)

Workstation operating software (graphic)

All inputs/outputs shall be provided via industry standard signals. Temperatures, humidity's, differential pressure signals, and other signals shall be of the following types:

0-20 mA, 4-20 mA, 0-5 VDC, 0-12 VDC, 1000-ohm platinum, 1000 ohm Balco, 10 k ohm Thermistor, Pulse inputs for pulsed contact monitoring, Custom, definable signals (accept sensor inputs from RTD devices, other than those of the manufacturer).

The operator shall have the ability to manually override automatic or centrally executed commands at the DDC panel via local, individual hand/off/auto operator override switches for each binary control point and individual gradual switches for each analog control type points. Only those points so designated will require manual overrides.

System capacity shall support future addition of DDC controls to future buildings on the site. The installed system shall include in every panel additional capacity for future installation of desired equipment, at the owner's discretion. Provide expansion capacity of at least 10% for every panel. Any Input/Output cards or modules required to utilize the spare points shall be provided. Expansion capacity shall include equal quantities of every point type; Analog input, Digital input, Digital output, and Analog output. Systems providing modulating outputs via pulse-width-modulation (PWM) techniques shall provide within each panel all the components required to implement the functions equivalent to an analog output.

Controllers shall be equipped with a minimum of one operator service port for the connection of a portable operators terminal. The service port shall be either a built-in RS-232-C data terminal port or an RJ-11 type jack which provides access to the RS-485 communication bus. Connection of a service device to a service port shall not cause the controller to loose communications with its peers or other networked device controllers. The service port shall allow utilization of the same portable operators terminal from any location.

Data relevant to panel locations, software flow charts, communication trunks, point list, wiring terminations, sensors, valve schedules, damper schedules and other pertinent equipment information, shall be submitted to the Architect for review.

Supervision, calibration and checkout of the system shall be by the employees of the local exclusive factory authorized temperature control contracting field office. The employees of the installing office shall be factory trained with training certification documentation.

1.4. SUBMITTALS

General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

Product Data for each type of product specified. Include manufacturer's technical Product Data for each control device furnished, indicating dimensions, capacities, performance characteristics, electrical characteristics, finishes of materials, installation instructions, and startup instructions.

Shop Drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection. Submit damper leakage and flow characteristics, plus size schedule for controlled dampers.

Shop Drawings containing the following information for each control system:

Schematic flow diagram showing fans, pumps, coils, dampers, valves, and control devices.

Each control device labeled with setting or adjustable range of control.

Diagrams for all required electrical wiring. Clearly differentiate between factory-installed and field-installed wiring.

Details of control panel faces, including controls, instruments, and labeling.

Written description of sequence of operation.

Trunk cable schematic showing programmable control unit locations and trunk data conductors.

Listing of connected data points, including connected control unit and input device.

System graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations.

System configuration showing peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.

Software description and sequence of operation.

Wiring diagrams detailing wiring for power, signal, and control systems and differentiating clearly between manufacturer-installed and field-installed wiring.

Maintenance data for control systems equipment to include in the operation and maintenance manual specified in Division 1. Include the following:

Maintenance instructions and spare parts lists.

Interconnection wiring diagrams with identified and numbered system components and devices.

Keyboard illustrations and step-by-step procedures indexed for each operator function.

Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.

Calibration records and list of set points.

Field Test Reports: Procedure and certification of pneumatic control piping system.

Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors. Revise Shop Drawings to reflect actual installation and operating sequences.

1.5. QUALITY ASSURANCE

Installer Qualifications: Engage an experienced Installer specializing in control system installations.

Manufacturer Qualifications: Engage a firm experienced in manufacturing control systems similar to those indicated for this Project and that have a record of successful in-service performance.

Startup Personnel Qualifications: Engage specially trained personnel in direct employ of manufacturer of primary temperature control system.

Comply with NFPA 90A.

Comply with NFPA 70.

Coordinate equipment selection with Division 16 Section "Fire Alarm Systems" to achieve compatibility with equipment that interfaces with that system.

1.6. DELIVERY, STORAGE, AND HANDLING

Store equipment and materials inside and protected from weather.

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

1.7. MANUFACTURERS

Manufacturers: Subject to compliance with requirements, provide products by the following:

Johnson Controls, Inc. branch office in Topeka, KS, or ACS Controls will be the base bid. Any other manufacturer seeking to bid must bid as an alternate to the base bid.

2. PART 2 – PRODUCTS

2.1. CONTROLLERS AND SENSORS

Thermostats or sensors mounted on outside walls shall be mounted on 1" minimum thickness, rigid fiberglass insulating base (or equal). All thermostat bulbs in water lines shall be installed in separable wells, packed with heat conductive compound. Furnish and install the necessary controllers and sensors. Typical sensors and controllers shall be as follows:

Low-Temperature Protection Thermostats: Low limit thermostats shall be of auto or manual reset type, with set point adjustment. The sensing element shall be 20 foot minimum and shall be installed completely across the coil. When any one foot of the element senses a temperature as low as the setpoint, the thermostat contacts shall open. Provide separate thermostats for each 25 sq. ft. of coil face area or fraction thereof. These shall contain double pole switches for simultaneous remote alarms or, as desired.

Duct Averaging Type Temperature Transmitter shall be a general purpose RTD sensing element, moisture resistant transmitter for indoor or outdoor mounting, or mounting into a duct. The operating range shall be as indicated with an accuracy of +/- 1% over the full range. The output shall be compatible with panel served. Transmitter shall be with 17 feet of sensor capillary.

Space Temperature Transmitter shall contain an RTD sensing element to monitor room air temperature in the range of 30 degrees F to 90 degrees F, unless indicated otherwise. The transmitter shall be factory calibrated to an accuracy of 1%. The assembly shall be installed within a metal ventilated enclosure suitable for wall mounting with a tamper-proof cover. The output shall be an ohms signal over a cable pair. Transmitter shall be factory calibrated to an accuracy of 1% percent.

Electric Contactors: Unless otherwise specified by individual equipment specifications, provide electric contactors for operating or limit-control of electric heating loads which are UL-listed for 100,000 cycles of resistive loads. Equip with replaceable molded coils and replaceable silver cadmium oxide contacts. Coat core laminations with heat-resistive inorganic film to reduce core losses. Provide line and load terminals on contactors with higher than 35-Amp rating, or provide one-piece formed-and-welded pressure type. Provide screw-type contactors for 35-Amp or lower rating. Equip field-mounted contactors with suitable steel enclosures and provide open-type mounting for those installed in factory-fabricated panels.

Damper Motors: Electronic direct-coupled actuation shall be provided.

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 fastening clamp assemble shall be of a 'V' bolt design with associated 'V' shaped toothed cradle attaching to the shaft for maximum strength and eliminating slippage. Spring return actuators shall have a 'V' clamp assembly of sufficient size to be directly mounted to an integral jackshaft of up to 1.05inches when the damper is constructed in this manner. Single bolt or screw type fasteners are not acceptable.

The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the entire rotation of the actuator. Mechanical end switches or magnetic clutch to deactivate the actuator at the end of rotation are not acceptable.

For power failure/safety applications, an internal mechanical spring return mechanism shall be built into the actuator housing. Non-mechanical forms of fail-safe operation are not acceptable.

All spring return actuators shall be capable of both clockwise and counterclockwise spring return

operation by simply changing the mounting orientation.

Proportional actuators shall accept a 0 to 10VDC or 0 to 20mA control input and provide a 2 to 10VDC or 4 to 20mA operating range. An actuator capable of accepting a pulse width modulating control signal and providing full proportional operation of the damper is acceptable. All actuators shall provide a 2 to 10VDC position feedback signal.

All 24VAC/DC actuators shall operate on Class 2 wiring and shall not require more than 10VA for AC or more than 8 watts for DC applications. Actuators operating on 120VAC power shall not require more than 10VA. Actuators operating on 230VAC shall not require more than 11VA.

All non-spring return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring return actuators with more than 60 in-lb torque shall have a manual crank for this purpose.

All modulating actuators shall have an external, built-in switch to allow reversing direction of rotation.

Actuators shall be provided with a conduit fitting and a minimum 3ft electrical cable and shall be pre wired to eliminate the necessity of opening the actuator housing to make electrical connections.

Actuators shall be Underwriters Laboratories Standard 873 listed and Canadian Standards Association Class 4813 02 certified as meeting correct safety requirements and recognized industry standards.

Actuators shall be designed for a minimum of 60,000 full stroke cycles at the actuator's rated torque and shall have a 2-year manufacturer's warranty, starting from the date of installation. Manufacturer shall be ISO9001 certified.

VAV box damper actuators shall be delivered to the terminal box manufacturer for installation. Provide with the devices installation instructions, cabling methods, support requirements, and drawing indicating the proper installation and placement of the device.

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Humidity Transmitter (Outside Air) shall be capable of providing continuous measurement of percent relative humidity with an accuracy of =/- 2% over the range 20 to 90% RH. The output shall be a 4 to 20 mA signal over a shielded cable pair. Transmitter shall have outside weather enclosure.

Electric Heat Current Controllers: Accomplish switching of load current by semiconductor devices located in load circuit of operation controller, and not by mechanical or mercury relays. Provide controllers which operated on zero-voltage switching principle, to minimize radio frequency interference; do not substitute devices incorporating phase control firing. Arrange power controllers, for loads of 10-kW or larger, for 3-phase operation. Incorporate a solid-state switch for loads of 48-Amps per phase or larger, in each ungrounded line of load circuit.

Airflow Sensor: Shall be a self-averaging, aerodynamic flow element capable of providing continuous measurement of airflow with an accuracy of -/+ 2% throughout the velocity range of 600 FPM and over. The sensor shall be made of aluminum for outside air applications. Where multiple elements are required, the output ports shall be manifolded together, external to the ductwork. Each element shall be furnished complete with mounting hardware, sealing gaskets, and signal connection fittings.

Demand Limiting Sensors: Current and voltage sensors for demand limiting.

2.2. DAMPERS

Provide all automatic dampers except for any specified to be provided under the individual HVAC unit specifications. Dampers for control of outside air and relief air shall be Ruskin CD-50 or equal, extruded aluminum, low leakage, parallel blade design with nylon bearings and blade and frame seals on all mating surfaces. Damper leakage shall not exceed 6 CFM per square foot at 4.0" water column, tested in accordance with AMA Standard 500. All other control dampers shall be Ruskin CD-35 or equal with 16 gauge steel blades, steel channel frame, oilite bearings, cadmium plated shafts and blade and jamb seals. Sectionalize outside air dampers as required to accurately provide the minimum outside air cfm, independent of the maximum outside air dampers.

2.3. CONTROL VALVES

Control valves shall be molded bellows or rubber diaphragm type with bronze or steel bodies for 250 psi ANSI rating or higher pressure as required, and with adjustable springs for sequencing of operation. Control valves 4" and larger controlling water flow may be butterfly type.

Valves controlling water flow shall, unless otherwise noted, be selected for a maximum pressure drop of 3 psig. A complete valve selection tabulation shall be submitted for approval.

Valves controlling steam shall, unless otherwise noted, be selected as follows:

Inlet Steam Pressure	Allowable Drop
15 psig and less	Up to steam pressure
Greater than 15 psig	50% of inlet absolute pressure

2.4. ELECTRICAL WIRING

All wiring and raceway required for the control system shall be the responsibility of the Control Company and shall meet the requirements of DIVISION 16.

2.5. CALIBRATION OF CONTROLS FURNISHED BY OTHERS

Terminal boxes which are furnished with factory control devices shall be field calibrated to assure proper operating sequence and coordination with the entire control system.

2.6. APPLICATION SPECIFIC CONTROLLERS (ASC)- HVAC APPLICATIONS

Application Specific Controllers (ASC) shall operate as a standalone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each ASC shall be a 16 bit microprocessor based, multi-tasking, multi-user, real-time digital control processor.

ASC's shall directly support the temporary use of a portable service terminal that can be connected to the ASC directly at the controller. The capabilities of the portable service terminal shall include, but not be limited to the following:

- Display temperatures, status, setpoints, control parameters
- Override binary output control, analog setpoints
- Program creation and modifications, including gain and offset constants

The ASC controllers shall permit the simultaneous operation of all control, communication facilities management and operator interface software, as programmed by the Contractor or User. Modification of the on-board ASC controller database shall be performed on-line using the built-in

or Portable Service Terminal interface. Systems which require the ASC to be removed from service while DDC control sequences are modified shall not be acceptable.

The operator interface to any ASC point data or programs shall be through the Stand Alone Direct Digital Panel or portable operator's terminal connected to any ASC on the network.

All system setpoints, proportional bands, control algorithms, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the ASC.

For compatibility to the environment of the mechanical systems, ASC shall have wide ambient ratings. ASC shall be rated for service from -40 F to 140 deg. F.

2.6.1. VAV TERMINAL CONTROLLERS (VAVTC)

VAV Terminal Controllers (VAVTC) shall support, but not be limited to the control of the following configurations of VAV boxes:

Single Duct Cooling Only

Single Duct Fan Powered Cooling and Heating

VAV Terminal Unit Controllers shall support the following types of point inputs and outputs:

- Self-calibrating Velocity Pressure input (0-2"WC)
- Proportional Cooling Outputs
- Box and Baseboard Heating Outputs (Proportional, or 1 to 3 Stages)
- Fan Control Output (On/Off Logic, or Proportional Series Fan Logic)
- Room Temperature Input
- Occupancy Override Input
- Occupancy or Status Input
- 0-100% Position Indication of Primary Damper Actuator - Direct feedback from damper actuator
- Room Setpoint Input
- Auxiliary Temperature Input
- Portable operator terminal interface

VAV terminal controllers shall be delivered to the terminal box manufacturer for installation. Provide with the devices installation instructions, cabling methods, support requirements, and drawings indicating the proper installation and placement of the device on the terminal box.

2.6.2. PACKAGED EQUIPMENT MODULES (PEM)

Packaged equipment modules shall support, but not be limited to the following types of systems:

- Air-handling unit
- Cabinet Unit Heaters

Packaged equipment modules shall support the following types of point inputs and outputs:

- Economizer switch over inputs
- Economizer Outputs

- Heating and Cooling outputs

Fan output

2.6.3. AIR HANDLING UNIT CONTROLLERS (AHU)

AHU controllers shall support all the necessary point inputs and outputs to perform the specified control sequences in a totally stand-alone fashion.

AHU controllers shall have a library of control routines and program logic to perform the sequence of operation specified in the "Sequence of Operation" portion of this specification.

2.6.4. OTHER SPECIALTY CONTROLLERS shall adhere to the intent of controllers listed above. In all cases they shall perform to meet the "Sequence of Operation" portion of this specification. Controllers shall be completely stand-alone using non-volatile memory for storage of programming and shall be in continuous direct communication with the network which forms the facility-wide building automation system.

2.7. STAND-ALONE DIRECT DIGITAL CONTROL (DDC) PANELS

Direct Digital Control (DDC) Panels shall be microprocessor based, multi-tasking, multi-user, digital control processors. A sufficient number of controllers shall be supplied to fully meet the requirements of this specification and the sequence of operation. The DDC controller shall provide a built-in operator interface with a multi-function keyboard. Devices without such built-in displays shall provide a permanently connected Portable Operators Terminal.

Each DDC panel shall have sufficient memory to support its own operating system and data bases including:

- Control processes
- Energy Management Applications
- Alarm Management
- Historical/Trend Data for all points
- Maintenance Support Applications
- Operator I/O
- Custom Processes
- Auto Dial/Auto Answer Communications
- Manual Override Monitoring

All control sequences programmed into the DDC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery to be retained. Power failures shall not cause the DDC memory to be lost, nor shall there be any need for batteries to be recharged or replaced to maintain the integrity of the controller database.

All control sequences shall be fully field programmable at the DDC controller, allowing for the creation or editing of an application sequence of operations.

Each DDC panel shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all subsidiary equipment. DDC panels shall provide both local and remote annunciation of any detected component failures, or repeated failure to establish communication. Indication of the diagnostic results shall be provided at each DDC panel.

DDC panels shall provide local status indication of critical data. Display shall either be by lights

and gauges or by scrolling information on a fixed display. Displays shall be capable of being modified by the owner.

LAN communication shall be at 64 kB or greater.

2.8. LOCAL AREA NETWORKS

The LAN shall utilize packetized transmissions, CRC 16 error checking, and distributed error recovery. Single or multiple DDC failures shall not cause loss of communication between other LAN-connected DDC's.

LAN connected DDC's shall be provided with a communications watchdog to assure that an individual DDC cannot permanently occupy the LAN. If a DDC is determined to be monopolizing communications, it shall be automatically shut down and an exception reported to annunciate this fact.

The LAN shall employ a token passing, peer-to-peer convention, same as or similar to the industry standard format IEEE 802.4. The content of messages shall be the manufacturer's standard. The Local Area Network components shall be manufacturer's standard or available from third party vendors which utilize the same chip implementation as used by the manufacturer.

Industry standard ANSI, RS-485 Network Communication System or Equivalent shall be utilized.

At each building entry and exit point, the wire communications trunk wiring shall be protected with a transient surge protection device. Transient surge protection is not necessary if the communication trunk, external to the building, is fiber optic in nature.

2.9. CONTROL SOFTWARE FEATURES

All necessary software to form a complete operating system, as described in the specification, shall be provided. The software programs specified in the section shall be provided as an integral part of all panels and shall not be dependent upon any higher level computer for execution.

System panels shall have as a standard feature of their software, complete libraries of control algorithms for DDC, Energy Management, and Facilities Management functions. These resident libraries of algorithms shall be drawn from for the creation of the application programming of each individual panel.

Operating system software shall be multi-tasking. The multi-tasking capability of the panels shall provide the capability to simultaneously perform at least, but not limited to, the following functions:

Downloading of application program changes to the panel without affecting the simultaneous operation of existing operating application programming.

Printing of scheduled or on-demand reports without preempting operator functions.

Controllers shall be provided with PID control loops that incorporate a self learning capability to eliminate all setup requirements for the Integral and Derivative of the control loop. Each control loop shall be individually tuned.

Control software shall include a provision for limiting the number of times each piece of equipment may be cycled within any one hour period.

After a loss of power and upon the resumption of normal power, the software shall analyze the status of all controlled equipment, compare it with normal occupancy scheduling, and turn equipment on or off as necessary to resume normal operation.

The system shall have the ability to perform all of the following energy management routines:

Time of Day/Calendar/Holiday Scheduling

Temporary schedule overrides

Optimum start/stop

Night setback

Enthalpy Switch over (Economizer & Cooling)

Peak Demand Limiting

Temperature compensated duty cycling

Fan speed/CFM control/Fan tracking

Interlock of Heating/Cooling/Lighting/Security

Reset of Hot Deck/Cold Deck

Reset of air and water temperatures

All programs shall be executed automatically without the need for operator intervention, and shall be flexible enough to allow user customization. Programs shall be applied to building equipment as described in the "Sequence of Operation" portion of this specification.

DDC Panels shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.

Process inputs and variables - It shall be possible to use any of the following in a custom process:

- Any system measured point data or status
- Any calculated data
- Any results from other processes
- User defined constants
- Arithmetic functions (+,-,*,/,square root, exp, etc.)
- Boolean logic operators (and,or,exclusive or, etc.)
- On delay/off delay/one shot timers

Process triggers - Custom processes may be triggered based on any combination of the following:

- Time interval
- Time of day
- Date
- Other processes
- Time programming

Events (e.g. point alarms)

Total Peer-To-Peer Access - A single process shall be able to incorporate measured or calculated data from any other panels on the local area network. Any point in the system can be viewed from any DDC panel thru the portable operator’s terminal. In addition, a single process shall be able to issue commands to points in any other panels on the local area network. This ability is not limited by hardware and is a function of the software.

Advisory/message generation - 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, buffer the information in a follow-up file, or cause the execution of a dial-up connection to a remote device such as a printer or pager.

Custom process documentation - All programs shall be documented. Al interrelationships defined by this program shall de documented via flow charts with English language descriptors. Submit flow charts for approval along with sequence of operation.

Continuous zone temperature histories - Each panel shall automatically and continuously maintain a history of the associated zone temperatures. A minimum of two samples per hour shall be stored for the previous 24 hours.

Alarm management shall be provided to monitor, buffer, and direct alarm reports to operator devices and memory files. Each panel 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 panels ability to report alarms be affected by either operator activity at a workstation or local I/O device, or communications with other panels on the network.

Point change report description - All alarm or point change reports shall include the point's English language description, and the time and date of occurrence.

Prioritization - 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 three priority levels shall be provided. Each panel shall automatically inhibit the reporting of selected alarms during system shutdown and start-up. Users shall have the ability to manually inhibit alarm reporting.

Report routing - Alarm reports, messages, and files will be directed to a user-defined list of operator devices, or workstations used for archiving alarm information.

Alarm messages - In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 40 character alarm message to more fully describe the alarm condition or direct operator response.

Auto-dial alarm management - In dial-up applications, the user shall be able to define which alarms will initiate a call to a remote operator device. For all other alarms, call activity shall be minimized by time-stamping and saving reports until an operator scheduled time, a manual request, or until the buffer space if full.

A variety of historical data collection utilities shall be provided to automatically sample, store, and display system data in the following ways:

Point histories - Each ASC panel shall be programmed to store point history files for all its analog and binary inputs and outputs. Samples for all points shall be stored to allow the user to immediately analyze equipment performance and all problem related events.

Performance Trends - ASC panels shall provide an input/output point trending utility that is capable of accumulating 48 analog point samples and 10 digital point samples, per Input/Output point. Each sample shall be taken on a user defined interval, ranging from 1 second to 255 hours per sample. The digital readings shall be on a change of state occurrence for the digital points. All samples shall be recorded with the engineering units for the value, along with a time and date identifier for each sample taken. The samples shall be protected against loss due to power interruptions through a battery or capacitor backup method for a minimum of 30 days.

Permanent Trends - DDC panels shall support logging and historical accumulation of trended data from the entire facility, or multiple sites as required. The operator shall be able to define which variables and how many samples will be displayed. The actual trend report data accumulation shall occur at the DDC panel. The reports, when full, may be rotated to maintain the last samples, dumped and started over or, printed at any printer in the system or shall be uploaded to the workstation for archiving in the connected on-site network, or from any number of remote sites which connect to the workstation via dial-up modem.

Panels shall be programmed to accumulate and store runtime hours for binary input and output points as identified in the sequence.

The totalization routine shall have a sampling resolution of one minute or less.

The user shall have the ability to define a warning limit for run time totalization. Unique user specified messages shall be generated when the limit is reached.

DDC panels shall automatically sample, calculate and store consumption totals, or count events, on a daily, weekly, or monthly basis for user selected analog and binary pulse input type points, or binary input points.

Totalization shall provide calculation and storage of accumulations in KWH, gallons, KBTU, tons, etc.

The user shall have the ability to define a warning limit. Unique user specified messages shall be generated when the limit is reached.

Programming shall be stored in non-volatile memory, which is not dependent upon the presence of a battery to be retained. Power failures shall not cause memory to be lost, nor shall there be any need for batteries to be recharged or replaced to maintain the integrity of the controller database. ASC & DDC panels shall allow for the creation of unique application control strategies. All control sequences shall be fully field programmable at ASC and DDC panels, allowing for the creation or editing of an application sequence of operations.

2.10. LOCAL I/O INTERFACE

Each ASC and DDC panel can connect to an individual operator's terminal for local command entry, instantaneous and historical data display, and program additions and modifications. No terminals will be provided but can be added at a later time.

The operator functions provided shall include but not be limited to the following:

Modify PID loop parameters, schedules, etc.

Enter overrides, setpoints, date, time, etc.

View all programming, overrides, and values of all parameters

Create new programming, assign terminal connections, etc.

Access to other panels with full capabilities as described above shall be provided from ASC and DDC panels.

Portable operator terminal shall provide English language prompting to eliminate the need for the user to remember command formats or point addresses. Prompting shall be provided consistent with the user's password level and type types of points being displayed.

Identification for all point data shall be consistent for all network devices. The same English language names used at workstations shall be used to access points at the portable operator's

terminal.

2.11. SYSTEM

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

System Security

User access shall be secured using individual security passwords and user names.

Passwords shall restrict the user to only the objects, applications, and system functions as assigned by the system manager.

User logon/logoff attempts shall be recorded.

The system shall protect itself from unauthorized use by automatically logging off following the last keystroke. The delay time shall be user definable.

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

Weekly Schedule. Provide separate schedules for each day of the week.

Exception Schedules. Provide the ability for the operator to designate any day of the year as an exception schedule. This exception schedule shall override the standard schedule for that day. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed it shall be discarded and replaced by the standard schedule for that day of the week.

Holiday Schedules. Provide the capability for the operator to define up to [99] special or holiday schedules. These schedules may be placed on the scheduling calendar and shall be repeated each year. The operator shall be able to define the length of each holiday period.

Optimal Start/Stop. The scheduling application outlined above shall support an optimal start/stop algorithm. This shall calculate the thermal characteristics of a zone and start the equipment prior to occupancy to achieve the desired space temperature at the specified occupancy time. The algorithm shall calculate separate sets of heating and cooling rates for zones that have been unoccupied for less then and greater than 24 hours. Provide the ability to modify the start/stop algorithm based on outdoor air temperature. Provide an early start limit in minutes to prevent the system from starting before an operator determined time limit.

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

Demand Limiting.

The demand limiting program shall monitor building power consumption from signals generated by a pulse generator (provided by others) mounted at the building power meter, or from a watt transducer or current transformer attached to the building main service entrance equipment.

The demand limiting program shall be based on a predictive sliding window algorithm. The sliding

window duration and sampling interval shall be set equal to that of the local Electrical Utility.

Control system shall be capable of demand limiting by resetting HVAC system set-points to reduce load while maintaining Indoor Air Quality and comfort control in the space.

Input capability shall also be provided for an end-of-billing period indication.

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

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

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

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

3. PART 3 - EXECUTION

3.1. TRAINING

Provide a minimum of 2 training sessions, 3 hours each, for personnel designated by the Owner.

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

Provide one copy of training material per student.

The instructors shall be factory-trained instructors experienced in presenting this material.

Classroom training shall be done using a network of working controller’s representative of the installed hardware or at the customer’s site.

At such time acceptable performance of the system hardware and software has been established, the Temperature Control Contractor shall provide on-site operator instruction to the owner's operating personnel. Operator instruction during normal working hours shall be performed by a competent Temperature Control Contractor's representative familiar with the system's software, hardware and accessories.

The Temperature Control Contractor shall give instruction to the Owner's personnel on the operation of all equipment within the building and describe its intended use with respect to the programmed functions specified. Operator orientation of the system shall include, but not be limited to, the overall operational program, equipment functions (both individually and as part of the total integrated system), commands, system generation, advisories, and appropriate operator intervention required in responding to the system's operation.

3.2. EXAMINATION

Verify that power supply is available to control units and operator workstation. Verify that field end

devices, and wiring are installed before proceeding with installation.

3.3. INSTALLATION

Install equipment as indicated to comply with manufacturer's written instructions.

Install software in control units and operator workstation. Implement all features of programs to specified requirements and appropriate to sequence of operation.

Connect and configure equipment and software to achieve the sequence of operation specified.

Verify location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation. Locate 54 inches above floor unless otherwise specified or indicated.

Install averaging elements in ducts and plenums in crossing or zigzag pattern.

Provide guards on thermostats where indicated on the plans.

Install damper motors on outside of duct in warm areas, not where exposed to outdoor temperatures.

Install labels and nameplates to identify control components according to Division 15 Sections specifying mechanical identification.

Install refrigerant instrument wells, valves, and other accessories according to Division 15 Section "Refrigerant Piping."

Install duct volume-control dampers according to Division 15 Sections specifying air ducts.

3.4. ELECTRICAL WIRING AND CONNECTIONS

Install raceways, boxes, and cabinets according to Division 16 Section "Raceways, Boxes, and Cabinets."

Install building wire and cable according to Division 16 Section "Low Voltage Wires and Cables."

Install signal and communication cable according to Division 16 Section "Control/Signal Transmission Media."

Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.

Install exposed cable in raceway.

Concealed cable may be installed open in concealed accessible areas using plenum rated cable.

Bundle and harness multiconductor instrument cable in place of single cables where a number of cables follow a common path.

Fasten flexible conductors, bridging cabinets and doors, neatly along hinge side; protect against abrasion. Tie and support conductors neatly.

Number-code or color-code conductors, except local individual room controls, for future identification and servicing of control system.

Connect electrical components to wiring systems and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals according to tightening requirements specified in UL 486A.

Connect manual reset limit controls independent of manual control switch positions. Automatic

duct heater resets may be connected in interlock circuit of power controllers.

Connect HAND-OFF-AUTO selector switches to override automatic interlock controls when switch is in HAND position.

3.5. STARTUP, TESTING AND ADJUSTMENTS

Manufacturer's Field Services: Provide the services of a factory-authorized service representative to start control systems.

Test and adjust controls and safeties.

Replace damaged or malfunctioning controls and equipment.

Setup, start, test, adjust and verify accuracy control systems. Make ready for Test and Balance Agency work.

Demonstrate compliance with requirements.

Verify all thermostats and VAV box controls are functioning properly.

Adjust, calibrate, and fine tune circuits and equipment to achieve sequence of operation specified.

Coordinate with and support as requested test and balance activities being performed by others.

3.6. DEMONSTRATION

A. Manufacturer's Field Services: Provide the services of a factory-authorized service representative to demonstrate and train Owner's maintenance personnel as specified above.

3.7. TESTING AND BALANCING COORDINATION

The temperature control contractor shall have a technical representative present with the balancing contractor on the first day of balancing for a minimum of four hours of active balancing and temperature controls coordination.

For the remainder of the balancing the temperature contractor may either have a technical representative present, or may furnish the balancer with the latest DDC software and all required interface devices. This includes instructions and coordination in the use of all interface devices, including laptop computers. There shall be no charge to the balancing contractor for the use of these interface devices and they shall be returned to the temperature controls contractor at the end of the balancing process.

END OF SECTION 239575