SECTION 15950 - CONTROLS

PART 1: GENERAL

1.01 DESCRIPTION

A. General: The control system shall be a direct digital control (D.D.C.) temperature control system and shall tie into the existing TAC I/A Enterprise Server (formerly Invensys) located in the St. Tammany Parish Justice Center in Covington La. Contact Bruce Crouch at 985-898-2792 for information on connection of this facility.

B. Any manufacturer wishing to quote this project shall contact the factory authorized licensee of TAC I/A Series for St. Tammany Parish for a quotation to provide the integration and software for connection into the existing operator workstation and operating software running at the St. Tammany Parish Justice Center.

C. Alternate manufacturer shall submit proposed control system architecture, control component data sheets, software specifications, company history, employee training history with certification documentation, list of references and contact information, resumes of employees working on this facility, list of projects similar in size in this area with contact information for approval by design engineer prior to bid. If approved manufacturer shall be listed by addendum.

1. Work includes, but is not limited to, the following:

a. Thermostats and Sensors

b. Control Valves

c. Control Dampers

d. Control Panels, Digital Control Cabinets (DDC), Personal Computer (P.C.I.), Etc.

e. Wiring of Control Devices

f. Control Devices

g. Sequence of Operation

2. Work Related and Specified Elsewhere:

a. Section 15050 - Basic Mechanical Materials and Methods

b. Section 15500 - Heating, Ventilating and Air Conditioning

c. Section 15550 - Heat Generation

d. Section 15650 - Refrigeration

e. Section 15750 - Heat Transfer

f. Section 15850 - Air Handling

1.02.1 QUALITY ASSURANCE

A SPECIFICATION COMPLIANCE REVIEW

1. The temperature control system/BAS contractor shall supply, at the time of bid opening, a paragraph by paragraph specification compliance report. The report shall indicate for each numbered paragraph, how the contractor meets the criteria of the paragraph. The following format must be utilized in completing the compliance report:

- Comply - without exception.
- Qualify - meet the functional intent. For each paragraph, the contractor shall identify all differences in specific functions stated in the given paragraph and provide a description of what is excluded or how the qualifying system will meet the function specified.
- Does not comply – cannot meet specified function

2. The control systems shall be installed under the direct supervision of the control manufacturer. The manufacturer shall provide instruction and direct work in progress and shall assume complete responsibility for the final installation. The control manufacturer shall perform all tests and make the necessary adjustments, and provide free service of the installation for one year from the date of acceptance by the Owner.

1.03 SUBMITTALS

A. In accordance with Section 15050 - Basic Mechanical Materials and Methods, furnish the following:

1. Manufacturer's Literature and Data:

a. All control items, I/O devices, D.C.C., P.C.I., valves, dampers, transformers, etc., associated with the systems.

b. Complete control drawings showing all wiring, controls and written sequence of operation.

c. General application and specific application programs.

2. Manuals: All maintenance and operating equipment associated with controls.

PART 2: PRODUCTS

2.01 DIGITAL CONTROLLERS (D.C.C.)

A. Main Components and Features:

1. The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system. The FMCS requires the incorporation of LonWorks Technologies using Free Topology Transceivers (FTT-10), and specific conformance to the LONMARK Interoperability Association’s v3.0 Physical and logical Layer guidelines in all unitary, terminal unit and other devices.

2. LonTalk communications protocol will be used on the communication network between FMCS controllers and other LonWorks devices to assure interoperability between all

devices within the network.

3. The FMCS shall support the direct integration of standard and non-standard communicating systems. At a minimum, the FMCS shall deliver connectivity at the Lon, IP, and HMI levels through standard offerings. The FMCS shall offer as a standard available solution, a minimum of 300 individual communicating interfaces to 3rd party products.

4. The FMCS shall provide a standard available test kit for development of additional interfaces by others, in addition to the FMCS manufacturer.

5. The FMCS shall provide compliance with the ASHRAE standard 135-P for BACnet interoperability with all devices within the FMCS.

6. The FMCS shall provide a high speed Network Interface that shall plug directly into the controller node which supports one of the following types of communication standards between controller nodes:

Ethernet

The intent for this project is to utilize the facility Ethernet Lan as the FMCS communications backbone between the area controllers and the thin clients.

The Network Interface shall employ Carrier Sense Multiple Access/Collision Detect (CSMA/CD) contention type protocol, which adheres to the industry standard format IEEE 802.3. The content of messages shall be the manufacturer's standard. The Network Interface shall be fully Internet Protocol (IP) compliant allowing connection to currently installed IEEE 802.3 compliant Ethernet Networks.

The Network Interface shall directly support connectivity to a variety of cabling types. As a minimum provide the following connectivity: 10Base2 (ThinNet RG-58 A/U Coaxial cabling with BNC connectors), 10BaseT (Twisted-Pair RJ-45 terminated UTP cabling).

Echelon

The FMCS shall employ LonTalk communications utilizing the LonWorks Neuron chip on the device bus, which conforms to the International Standards Organization’s (ISO) seven layer Open Systems Interconnect (OSI) network protocol model. The content of messages shall be the manufacturer's standard. The Neuron chip and a transformer-isolated transceiver shall provide for 78.8kbps communications over Category 4 Unshielded Twisted Pair (UTP) cabling.

To facilitate facility expansion or to support large Wide Area Networks (WANs) the Network Interface shall directly support a minimum of 4 logical networks using the same physical network (Ethernet or Echelon). Each logical network shall support a minimum of 126 controller nodes.

The ability to support bi-directional access to remote controller nodes shall be supported by a single point of connection. The ability to monitor and edit system data shall be provided via the controller node remote

communications connection. Connection via the HMI, the GP as well as a standard VT-100 terminal interface shall be provided. Support for solicited as well as unsolicited communications is a requirement.

Other Requirements:

Each stand-alone digital control cabinet shall be programmable through the hand held operator terminal or C.P.I. terminal. Software architecture shall allow both standard setups of point types, EMS Programs, loops of related parameters as well as custom program linking with math and logic. In addition, the network shall allow the building operations a means of interrogating input/output sensor conditions, such as interrogating the values of analog sensor input upon request, or the status of control via the standard keyboard and display unit, or the P.C.I. terminal unit.

All programming shall allow a minimum of three levels of entry with code requirements; level one for general data entry; level two for overall system entry; level three for programming.

B. DDC VAV Box Controller

1. Controls shall be microprocessor based Pressure Independent Variable Air Volume Digital Controllers, as shown in the drawings. The DDC VAV shall be a single integrated package consisting of a microprocessor, power supply, damper actuator, differential pressure transducer, field terminations, and application software. An alternate model shall be offered that allows for direct connectivity to an external actuator for those applications that employ a non-butterfly style damper configuration. All input/output signals shall be directly hardwired to the DDC VAV controller. The internal actuator shall employ a manual override that allows for powered or non-powered adjustment of the damper position. In all cases, the controller shall automatically resume proper operation following the return of power to, or control by the DDC VAV. Programming, configuring and/or troubleshooting of input/output signals shall be easily executed through the DDC sensor or GP tool connected at the wall sensor location.

2. The DDC VAV controller algorithms shall be completely programmable with the GP tool on site. DDC VAV controllers that are only field configurable will not be accepted since they cannot provide the special sequences required.

3. The DDC VAV control algorithms shall be designed to limit the frequency of damper repositioning, to assure a minimum 10-year life from all components. The DDC VAV shall provide internal differential pressure transducer for pressure independent applications with an accuracy of ± 5 %. Flows through transducers requiring filter maintenance are not acceptable. The DDC VAV shall provide zone control accuracy equal to or better than +/- 1 degree Fahrenheit. Systems providing control accuracy's greater than +/- 1 degrees Fahrenheit are not acceptable. With the submittal package, contractor shall provide performance data that verifies control accuracy of the DDC VAV.

4. All input/output signals shall be directly hardwired to the DDC VAV. A minimum of one input point of the DDC VAV shall employ a universal configuration that allows for flexibility in application ranging from dry contact, resistive, to voltage/current sourced inputs. If a universal point is not available, a minimum of one input point (each) of the dry contact, resistive and analog voltage/current types must be provided on every

controller. The outputs of the DDC VAV shall be of the relay and universal analog form. All digital outputs shall be relay type. DDC VAV devices utilizing non-relay outputs shall provide an interface relay for all points. All analog outputs shall be programmable for their start points and span to accommodate the control devices. Configuration of all I/O points shall be accomplished without physical hardware jumpers, switches or settings. Troubleshooting of input/output signals shall be easily executed with the Graphical Programming tool or a volt-ohm meter (VOM). All I/O points shall be utilized by the local DDC VAV or shall be available as I/O points for other controllers throughout the network.

5. The VAV terminal manufacturer shall provide a multi-point, averaging, differential pressure sensor mounted on the inlet to each VAV box. The VAV terminal unit manufacturer shall supply a line to low voltage transformer, of sufficient capacity, to power the DDC VAV plus all reheat valves and/or contactors and fan circuits associated with the VAV terminal and actuator assemblies. The FMCS contractor shall provide all reheat control valves to the mechanical contractor for mounting and piping. The FMCS contractor shall provide and install all wiring between the valve and DDC VAV controller and between the room sensor and the DDC VAV controller.

C. DDC VAV - Air Balancing

1. Through the portable GP tool, the DDC VAV shall support a fully prompted Air Balance sequence. The GP tool shall, when connected through the wall sensor, access the connected DDC VAV unit. The air balance sequence shall step the balancing contractor through the checkout and calibration of the DDC VAV. Upon completion of the balancing sequence, the flow values presented by the DDC VAV shall match those observed by the balancing contractor's measurement equipment. Additionally, upon completion of the air balance, the GUI shall archive the balance settings for future use if the controller were to require replacement. Systems not able to provide a formatted air balance GP tool shall provide an individual full time during the Air-balancing process to assure full balance compliance.

D. DDC Sensor (for all DDC controllers)

1. The DDC Sensor shall connect directly to the DDC Controller and shall not utilize any of the I/O points of the controller. The DDC Sensor shall provide a two-wire connection to the controller that is polarity and wire type insensitive. The DDC Sensor shall provide a communications jack for connection to the LON communication trunk to which the DDC controller is connected. The DDC Sensor, the connected controller, and all other devices on the LON bus shall be accessible by the Graphical Programming tool.

The DDC Sensor shall be supplied in the following variations;

i. Tamper-resistant (no display)
ii. Tamper-resistant with tenant override
iii. Basic user functions (LCD display and setpoint adjustment and tenant override)
iv. Full user functions (LCD display and network-variable access and tenant override)
v. ASHRAE 95 compliance (LCD display and sub-base functionality)

2. The DDC Sensor shall be provided in a modular configuration that allows for the rough in of all wiring without the presence of the electronics or esthetic covering. The DDC

Sensor shall allow for the customization of the color on the esthetic covering as a standard offering. User interface with the DDC Sensor shall be provided as a configurable function by the FMCS, and shall offer password protection for access to network variable editing. Multiple network variables shall be accessible and editable by the DDC Sensor. Icons shall be utilized to represent sensor and controller function status, affording independence from a single language for use interface.

E. INTEROPERABLE LONMARK CONTROLLERS (ILC)

1. Controls shall be microprocessor based Interoperable LONMARK Controllers (ILC), bearing the applicable LONMARK interoperability logo on each product delivered. ILCs shall be provided for Unit Ventilators, Fan Coils, Heat Pumps, VAV Terminal Boxes and other applications as shown on the drawings. ILCs shall be based on the Echelon Neuron 3150 microprocessor working from software program memory which is physically located in the ILC. The application control program shall be resident within the same enclosure as the input/output circuitry, which translates the sensor signals.

2. To simplify controls and mechanical service troubleshooting, the ILC shall be mounted directly in the control compartment of the unitary system. The ILC shall be provided with a sheet metal or polymeric enclosure that is constructed of material allowing for the direct mounting within the primary air stream, as defined by UL-465. The direct mounting shall allow all controls maintenance and troubleshooting to be made while at the unitary equipment.

3. The ILCs shall communicate with the GUI at a baud rate of not less than 78.8K baud. The ILC shall provide LED indication of communication and controller performance to the technician, without cover removal.

4. The ILCs shall be fully supported and communicate with any and all GUI(s) on the bus.

5. The ILC shall provide a –40 to 140 degree Fahrenheit ambient operating temperature range. The ILC shall be provided in a modular configuration that allows for the rough in of all wiring without the presence of any of the ILC electronics. ILC devices that require the electronics to be present at the time of wiring, will require an additional controller to be provided for every 10 devices on the drawings, to allow for the preconfiguration and storing for service purposes.

6. All input/output signals shall be directly hardwired to the ILC. For all non-VAV terminal applications, a minimum of two input points of the ILC shall employ a universal configuration that allows for flexibility in application ranging from dry contact, resistive, to voltage/current sourced inputs. If universal points are not available, a minimum of two input points (each) of the dry contact, resistive and analog voltage/current types must be provided on every controller. The outputs of the ILC shall be of the relay and universal analog form. All digital outputs shall be relay type. ILC devices utilizing non-relay outputs shall provide an interface relay for all points. All analog outputs shall be programmable for their start points and span to accommodate the control devices. Configuration of all I/O points shall be accomplished without physical hardware jumpers, switches or settings. Troubleshooting of input/output signals shall be easily executed with the Graphical Programming tool (GP) or a volt-ohm meter (VOM). All I/O points shall be utilized by the local ILC or shall be available as I/O points for other controllers throughout the network.

7. All ILCs shall be fully application programmable and shall at all times maintain their LONMARK certification. All control sequences within or programmed into the ILC

shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained.

8. The ILC shall be provided with the ability to interface with the Graphical Programming tool. The interface port shall be provided at the wall sensor or within the unitary equipment, as specified on the plans. The interface port shall allow the GP to have full functionality as described in GP section of this specification. Through the connected controller all ILC devices on the LON bus shall be accessible by the Graphical Programming tool.

9. Mechanical equipment manufacturers desiring to provide ILC type controls as factory mounted equipment, shall provide a separate bid for their products less all controls, actuators, valve assemblies and sensors, which are specified to be provided by the FMCS contractor.

F. INTEROPERABLE DIGITAL CONTROLLERS (IDC)

1. Controls shall be microprocessor based Interoperable LonWorks Digital Controllers (IDC), providing interoperability with all LONMARK and LonWorks devices. IDCs shall be provided for any equipment applications as required, as shown on the drawings. IDCs shall be based on the Echelon Neuron Hosted microprocessor architecture, working from software program memory that is physically located in the IDC. The application control program shall be resident within the same enclosure as the input/output circuitry, which translates the sensor signals.

2. All IDCs shall be fully application programmable utilizing graphical objects. All control sequences programmed into the IDC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained. Systems that only allow selection of sequences from a library or table are not acceptable.

3. The IDC shall be provided with the ability to interface with the Graphical Programming tool. The interface port shall allow the GP to have full functionality as described in GP section of this specification. Through the interface port all IDC devices on the LON bus shall be accessible by the Graphical Programming tool.

4. The IDCs shall communicate with the SDC at a baud rate of not less than 78.8K baud. The IDC shall have as a minimum ambient operating temperature range of 32 to 122 degrees Fahrenheit.

5. The IDC shall be fully supported by the Graphical User Interface (GUI).

6. All input/output signals shall be directly hardwired to the IDC. All controllers shall employ a universal input configuration that allows for flexibility in application ranging from dry contact, resistive, to voltage/current-sourced inputs. If universal points are not available, a minimum of one spare input point (each) of the dry contact, resistive and analog voltage/current types must be provided for each input point utilized. IDC devices shall provide digital and analog output types and quantities consistent with the requirements of the application requirements. Troubleshooting of input/output signals shall be easily executed with the Graphical Programming tool or a volt-ohm meter (VOM). All I/O points shall be utilized by the local ILC or shall be available as I/O points for other controllers throughout the network.

7. To simplify controls and mechanical service troubleshooting, the IDC shall be mounted directly in or on the control compartment of the air handling system. The IDC shall be provided in a NEMA 1 enclosure to accommodate direct mounting on the equipment to be controlled. The IDC shall be constructed in a modular orientation such that service of the failed components can be done quickly and easily. The modular construction should limit the quantities of printed circuit boards to a maximum of two. All logic, control system, power supply and input/output circuitry shall be contained on a single plug-in circuit board. All wiring terminations shall be made to serviceable connections allowing controller reconfiguration without the removal of any terminated wires. This shall allow all controls maintenance and troubleshooting to be made while at the air handling unit. The IDC shall be directly wired to sensory devices, staging relays or modulating valves for heating and cooling.

8. The FMCS contractor shall provide and field install all IDCs specified under this section. Mechanical equipment manufacturers desiring to provide IDC type controls as factory mounted equipment, shall provide a separate bid for their products less all controls, actuators, valve assemblies and sensors, which are specified to be provided by the BAS/Temperature control contractor.

2.02 GRAPHICAL USER INTERFACE SOFTWARE

A. OPEN ARCHITECTURE, BROWSER BASED GUI

1. A graphical user interface shall be included with the host computer system software. This user interface shall allow, with proper password access, full interaction with the system including, but not limited to, viewing and modifying data, database administration, configuration of communications parameters, password and security administration, programming and configuration of objects, receipt, routing and acknowledgement of alarms, and development of graphic screens.
2. The user interface shall employ browser-like functionality for ease of navigation. It shall include a tree view 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 techniques similar to those in a commercially available Web Browser. 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.
3. 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 user interface shall support the use of scanned pictures.
4. Graphics developed for the user interface shall be capable of being used by a standard Web Browser client, without the need to develop additional graphic screens specifically for the Web Browser. Graphics used by the Web Browser client(s) shall be capable of being edited using a standard HTML document editor.
5. Graphic screens shall have the capability to be overlaid with text, real-time values, command and adjust, animation, color spectrum, logs, graphs, HTML document links, and schedule graphic objects, as well as links to other graphic screens.
6. Modifying common application objects, such as schedules, calendars, and set points shall be accomplished in a graphical manner.
7. Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
8. Holidays shall be set by using a graphical calendar without requiring any keyboard entry from the operator.

9. Commands issued 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.
10. 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.

B. 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.
2. A separate alarm notification window will supercede 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.

C. WEB BROWSER CLIENTS

1. 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 resident on the client machine or manufacture-specific browsers shall not be acceptable.
2. The Web Browser client shall support at a minimum, the following functions:

   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 techniques to prevent unauthorized access shall be implemented.

   Graphical screens developed for the GUI shall be the same screens used for the Web Browser client. Storage of the graphical screens shall be in the system, without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.

   Depending on user access privileges, the user shall be able to view data, modify and command objects such as start/stop, and adjust set points. In addition, users can be provided with the ability to view logs and view and acknowledge alarms.

3. The system shall provide the capability to specify a user's (as determined by the log-on user identification) home page. The capability to limit the user to just their home page shall be provided. From the home page, links to other views, or pages in the system shall be possible.
4. Graphic screens on the Web Browser client shall support hypertext links to other Web pages on other Internet or Intranet sites.

D. OBJECT LIBRARIES

1. A standard library of objects shall be included for development and setup of application logic, user interface displays, system services, and communication networks.
2. 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.

3. 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.
4. The library shall include applications or objects for the following functions:

Scheduling Object. Provide a BACnet compliant, 7-day plus holiday & temporary scheduling object to allow for a minimum of 10 on/off events per day. Data entry to be by graphical sliders to speed creation and selection of on-off events.

Calendar Object. Provide a BACnet compliant 12-month calendar object to allow for holiday or special event data entry. Data entry to be by graphical "point-and-click" selection. This object must be "linkable" to any or all scheduling-objects for effective event control.

Duty Cycling Object. Provide a universal duty cycle object to allow repetitive on/off time control of equipment as an energy conserving measure. Any number of these objects may be created to control equipment at varying intervals

Temperature Override Object. Provide a temperature override object that is capable of overriding equipment turned off by other energy saving programs (scheduling, duty cycling etc.) to maintain occupant comfort or for equipment freeze protection.

Start-Stop Time Optimization Object. Provide a start-stop time optimization object to provide the capability of starting equipment just early enough to bring space conditions to desired conditions by the scheduled occupancy time. Also, allow equipment to be stopped before the scheduled un-occupancy time just far enough ahead to take advantage of the building's "flywheel" effect for energy savings. Provide automatic tuning of all start / stop time object properties based on the previous day's performance.

Demand Limiting Object. Provide a comprehensive demand-limiting object that is capable of controlling demand for any selected energy utility (electric, oil, and gas). The object shall provide the capability of monitoring a demand value and predicting (by use of a sliding window prediction algorithm) the demand at the end of the user defined interval period (1-60 minutes). This object shall also accommodate a utility meter time sync pulse for fixed interval demand control. Upon a prediction that will exceed the user defined demand limit (supply a minimum of 6 per day), the demand limiting object shall issue shed commands to either turn off user specified loads or modify equipment set points to effect the desired energy reduction. If the list of sheddable equipment is not enough to reduce the demand to below the set point, a message shall be displayed on the users screen (as an alarm) instructing the user to take manual actions to maintain the desired demand. The shed lists are specified by the user and shall be selectable to be shed in either a fixed or rotating order to control which equipment is shed the most often. Upon suitable reductions in demand, the demand-limiting object shall restore

the equipment that was shed in the reverse order in which it was shed. Each sheddable object shall have a minimum and maximum shed time property to effect both equipment protection and occupant comfort.

5. At a minimum, the library shall include services to support LonWorks and BACnet networks.
6. The library shall include control objects for the following functions at a minimum:

Analog Input Object - Minimum requirement is to meet the BACnet standard for data sharing. Allow high, low and failure limits to be assigned for alarming. Also, provide a time delay filter property to prevent nuisance alarms caused by temporary excursions above or below the user defined alarm limits.

Analog Output Object - Minimum requirement is to meet the BACnet standard for data sharing.

Binary Input Object - Minimum requirement is to meet the BACnet standard for data sharing. The user must be able to specify either input condition for alarming. This object must also include the capability to record equipment run-time by counting the amount of time the hardware input is in an "on" condition. The user must be able to specify either input condition as the "on" condition.

Binary Output Object - Minimum requirement is to meet the BACnet standard for data sharing. Properties to enable minimum on and off times for equipment protection as well as interstart delay must be provided. The BACnet Command Prioritization priority scheme must also be incorporated to allow multiple control applications to execute commands on this object with the highest priority command being invoked. Provide sixteen levels of priority as a minimum. Systems not employing this contention resolution shall not be acceptable.

PID Control Loop Object - Minimum requirement is to meet the BACnet standard for data sharing. Each individual property must be adjustable as well as to be disabled to allow proportional control only, or proportional with integral control, as well as proportional, integral and derivative control.

Comparison Object - Allow a minimum of two analog objects to be compared to select either the highest, lowest, or equality between the two linked inputs. Also, allow limits to be applied to the output value for alarm generation.

Math Object - Allow a minimum of four analog objects to be tested for the minimum or maximum, or the sum, difference, or average of linked objects. Also, allow limits to be applied to the output value for alarm generation.

Custom Programming Objects - Provide a blank object template for the creation of new custom objects to meet specific user application requirements. This object must provide a simple BASIC-like programming language that is used to define object behavior. Provide a library of functions including math and logic functions, string

manipulation, and e-mail as a minimum. Also, provide a comprehensive on-line debug tool to allow complete testing of the new object. Allow new objects to be stored in the library for re-use.

Interlock Object - Provide an interlock object that provides a means of coordination of objects within a piece of equipment such as an Air Handler or other similar types of equipment. An example is to link the return fan to the supply fan such that when the supply fan is started, the return fan object is also started automatically without the user having to issue separate commands or to link each object to a schedule object. In addition, the control loops, damper objects, and alarm monitoring (such as return air, supply air, and mixed air temperature objects) will be inhibited from alarming during a user-defined period after startup to allow for stabilization. When the air handler is stopped, the interlocked return fan is also stopped, the outside air damper is closed, and other related objects within the air handler unit are inhibited from alarming thereby eliminating nuisance alarms during the off period.

Temperature Override Object - Provide an object whose purpose is to provide the capability of overriding a binary output to an "On" state in the event a user specified high or low limit value is exceeded. This object is to be linked to the desired binary output object as well as to an analog object for temperature monitoring, to cause the override to be enabled. This object will execute a Start command at the Temperature Override level of start/stop command priority unless changed by the user.

Composite Object - Provide a container object that allows a collection of objects representing an application to be encapsulated to protect the application from tampering, or to more easily represent large applications. This object must have the ability to allow the user to select the appropriate parameters of the "contained" application that are represented on the graphical shell of this container.

7. The object library shall include objects to support common LonMark devices. These devices shall include, but not be limited to, devices for control of HVAC, lighting, access, and metering.

E. HOST COMPUTER HARDWARE (PERSONAL COMPUTER)

1. The personal computer shall be an Intel Pentium based computer (minimum processing speed of 400 Mhz with 128 MB RAM, expandable to 256 MB and a 10-gigabyte minimum hard drive). It shall include a 32X CD-ROM drive, 3.5" floppy drive, a 100 MB Zip drive, 2-parallel ports, 2-asynchronous serial ports and 2-USB ports. A minimum 17", 28-dot pitch SVGA color monitor with a minimum 80 Hz refresh rate shall also be included.
2. A system printer shall be provided. Printer shall be laser type with a minimum 600 x 600-dpi resolution and rated for 8 PPM print speed minimum.

F. PERSONAL COMPUTER INTERFACE (P.C.I.)

1. Provide a notebook PC equal to as a minimum Pentium 350 MHz microprocessor: 4GB

disk storage; 1.44 MB diskette drive and 128 MB of memory. This system shall be provided with a high-resolution color monitor with graphic board with 4MB ROM, to perform all software functions and tie into network system. Provide all software including windows based package with mouse driven for all data logging board with "Excel" spread sheet for customizing.

G. GRAPHICAL PROGRAMMER (GP)

1. Along with the P.C.I, provide the GP software tools. The P.C.I. computer shall include a PCC-10 network interface card to allow for direct connection to the Lon bus. Alternately, or in addition to, the GP tool can reside on the primary HMI platform when direct LONMARK connectivity is made through the HMI. The GP is a graphical object-oriented Visio-based drawing tool that provides an intuitive interface for network design integrating LonWorks capabilities into Windows NT based applications. These functions shall include Network Management services such as device installation, device configuration, diagnostics, maintenance, and defining network data connections between system controllers, know as "binding." All ILCs and IDCs shall be programmed using the GP. The utility shall be capable of editing downloading application programs to all of the devices within the FMCS locally *and remotely via the internet*.

H. HARD COPY TERMINAL

1. A compact laser type desktop printer shall be provided. The printer shall include the ability to generate alarm, data, and report printouts without any additional software. The printer shall be located beside the P.C.I. terminal.

I. NETWORK LINK AND MODEM

1. Provide as a minimum 54,000 BPS modem to allow access to the system from a remote location through a telephone line. The modem shall provide all the features of the Hayes Smart Modem 2400.
2. Networking: provide networking card and software to tie P.C.I. into owners network.

2.03 CONTROL PANELS

A. Wherever three or more manual switches, relays, controllers, or other control devices (not including room thermostats or duct-mounted instruments) are required for a ventilating unit or system, such devices shall be grouped and mounted in a control panel. Panels shall be made of enameled steel. Panels shall be secured to walls or unit casings with sufficient space in the rear for access to wiring, etc.

2.04 AUTOMATIC DAMPERS

A. All automatic dampers shall be furnished under this paragraph. Automatic dampers shall be constructed and installed in accordance with the following specifications:

1. Damper Blades: All automatic dampers shall be of the balanced type, factory-fabricated, with galvanized steel blades fully gasketed, mounted horizontally in welded steel frames. Damper blades shall be not lighter than 16 gauge steel, no more than eight inches wide, and shall have interlocking edges.

2. Modulating Dampers: All modulating dampers shall be of the opposed blade type.

3. Damper Size and Bearings: Damper blades shall have steel trunnions mounted in

oil-impregnated bearings. Dampers shall be not more than 48" in length between bearings.

4. Frames: Damper frames shall be of welded channel or angle-iron, with heavy steel corner gussets and braces or stiffened with steel tie-rods where necessary. Frames shall be painted with aluminum paint to insure against rusting.

5. All dampers shall be guaranteed to close tight, and shall provide substantially the full area of the opening when open. All outdoor air intakes and all exhaust ducts to outside shall have damper blades with gasketed seats of low leakage design.

6. Damper Linkages: Damper-operating links shall be steel or brass rods, adjustable in length with ball and socket joints and of such proportions that they will withstand without appreciable deflection, a load equal to not less than twice the maximum operating force of the damper motor.

2.05 DIRECT DIGITAL CONTROL (D.D.C.) OF OPERATORS

A. General: Direct control capability using a custom control program, manual command, or time program initiated commands shall be provided as a standard features of this system. It shall be possible to input a sensor or group of sensors to the D.C.C. unit, process the data using the features of a Custom Control Program, and output an analog control signal or setpoint directly to a controlled valve or damper. It shall not be necessary to provide intermediate controllers to condition the signal for the valve or damper actuator. The output signal shall be scaled in software to be compatible with industry standard control signal variables, such as three (3) to six (6) volts, six (6) to nine (9) volts.

B. Main Components and Features:

1. Motors: For each automatically-controlled damper or valve, a suitable damper motor or motors shall be provided in accordance with the following specifications:

a. Operator: Motors shall be of the fully proportioning type, non-hydraulic. The motor shall have a rating of not less than twice the thrust needed for actual operation of the damper of valve.

b. Adjustments: Motor shall have adjustable stops to adjust the open and closed positions and adjustable return spring on damper motor.

c. Mounting: Damper motor shall be provided with suitable mounting base and frame. The damper motor and mounting base shall not be mounted directly on cold or insulated ducts and casings, but shall be mounted outside the insulated covering in such a manner as to prevent sweating and interference with the insulation.

2. Sensors: Linear precision resistance elements and resistance averaging elements shall be provided for temperature sensing. Their range shall be –50 to 250 degrees Fahrenheit with an accuracy of +/- 0.5 degrees Fahrenheit.

2.06 AUTOMATIC CONTROL VALVES

A. Automatic control valves on low-pressure steam shall be furnished as follows:

1. Valves shall have removable composition discs and with monel stem. Bodies 2" or smaller shall be bronze with screwed ends. Bodies 2-1/2" and larger shall be cast iron with flanged ends. Valve bodies, trim and stuffing boxes shall be designed for not less than 125 psi

working pressure. Valve packing shall be non-lubricated teflon packing.

2. Shall be fully proportioning as herein before described under operators.

3. Water valves shall be sized for approximately 2 psi drop.

4. Chilled water valves sized as indicated on plans.

2.07 ROOM ELEMENTS

A. Sensors shall be securely attached to a suitable base mounted on the wall or other building surface. Each sensor shall be located where shown or, if not shown, where it will respond to the average temperature in the room. Sensors generally shall be mounted 5 feet above floor and shall not be mounted on outside walls or partitions between offices if other locations are possible. If located on outside wall, it shall have an insulated base.

B. Provide guards for all sensors with approved security fastening system where subject to abuse such as manufacturing areas, corridors, etc.

2.08 REMOTE TEMPERATURE SENSORS

A. Remote Temperature Sensors for controlling equipment with remote adjustment shall be adjustable from 45° to 75° Fahrenheit with a minimum sensitivity of not less than one degree plus or minus.

PART 3: EXECUTION

3.01 WIRING

A. Under this section provide and install all wiring associated with the temperature control system. Equipment and wiring not provided under electric sections shall be furnished and mounted under this section.

1. Low voltage control wiring (24V) shall be Type THHN stranded No. 16 or multiconductor No. 18 or better.

2. Communication wiring shall be Lon compliant Category 4 or 5 twisted unshielded pair.

3. Line voltage wiring (120V or higher) shall be No. 12 minimum and run in conduit.

4. All wiring shall be in accordance to Division 16 - Electrical.

5. Exposed wire in mechanical rooms shall be in conduit. Concealed wire shall be plenum grade, run together and supported every 4 feet. All wiring shall be run at right angles to the building. Drops down walls shall be in conduit.

PART 3 - SEQUENCE OF OPERATION

3.1 CHILLED WATER SYSTEM

A. Chilled water pump nos. 1 and 2 shall be started and stopped from the BAS system through the "Auto" position of the Hand-Off-Auto selector switch of the magnetic motor starter. Once energized and

run status has been proven via a current sensing relay, status indication shall be displayed at the BAS.

B. Air cooled chiller nos. 1 and 2 shall be energized from the BAS system and shall be controlled from the internal chiller controls once chilled water flow has been proven from a differential pressure type flow switch across each chiller. Each chiller shall also be interlocked to the chilled water pump magnetic motor starter per the chiller manufacturer's recommendations.

C. An air cooled chiller alarm status indication shall be provided for each chiller, chiller run status for each chiller, chilled water pump status, chilled water supply temperature for each chiller, chilled water return temperature for each chiller, outside air temperature, chilled water common supply temperature, and chilled water common return temperature shall all be displayed at the BAS.

3.2 VARIABLE AIR VOLUME AIR HANDLING UNIT

A. Unit fan shall be started and stopped through the Hand-Off-Auto switch on the cover of the magnetic motor starter based on a time schedule from the BAS. Once the unit fan is energized the automatic temperature control system shall be placed in operation and the unit fan status via current sensing relay shall be displayed at the BAS and the outside air damper shall open.

B. A duct mounted smoke detector provided by division 16000 and located in the pure supply air stream shall de-energize the unit fan when particles of combustion are sensed. On units above 15000 cfm, a duct mounted smoke detector shall also be located in the return air stream in addition to the one in the supply air.

C. A chilled water coil discharge temperature sensor shall modulate the normally closed chilled water valve to maintain a setpoint of 55 degrees F. The VAV box space sensor requiring the greatest demand shall reset the supply air temperature.

D. A manual reset, low limit thermostat, shall deenergize the unit fan and close the outside damper if the temperature falls below 35 degrees F. An alarm status of the low limit thermostat shall be displayed at the BAS.

E. A static pressure sensor located 2/3 down the supply air duct shall modulate the variable frequency drive to maintain a setpoint of 1.5" wg. A manual reset, static pressure high limit controller shall de-energize the unit fan if the static pressure in the supply air duct reaches 3" wg. An alarm status of the static high limit sensor shall be displayed at the BAS.

F. An IAQ (Temp, Rh%, CO, CO2, and VOC's) sensor located in the pure return air stream shall modulate the outside air damper to maintain a setpoint of 800ppm.

G. Individual room thermostats shall maintain the room temperature setpoint of 74 degrees F cooling and 70 degrees F heating by modulating the variable air volume (VAV) box damper actuator and the 2-way hot water reheat coil valve. The variable air volume box requiring the greatest demand for cooling shall reset the supply air temperature. (See VAV box sequence for further information).

H. When the unit fan is deenergized, the automatic control system shall be inoperable, and the outside air damper and the chilled water valve shall close to the coil.

I. All analog and digital inputs and outputs shall be displayed at the BAS.

3.3 CONSTANT VOLUME AIR HANDLING UNIT

A. Unit fan shall be started and stopped through the Hand-Off-Auto switch on the cover of the magnetic

motor starter based on a time schedule from the BAS. Once the unit fan is energized the automatic temperature control system shall be placed in operation and the unit fan status via current sensing relay shall be displayed at the BAS and the outside air damper shall open.

B. A duct mounted smoke detector provided by division 16000 and located in the pure supply air stream shall de-energize the unit fan when particles of combustion are sensed. On units above 15000 cfm, a duct mounted smoke detector shall also be located in the return air stream in addition to the one in the supply air.

C. A manual reset, low limit thermostat, shall deenergize the unit fan and close the outside damper if the temperature falls below 35 degrees F. An alarm status of the low limit thermostat shall be displayed at the BAS.

D. A space temperature sensor shall maintain the room temperature setpoint of 74 degrees F cooling and 70 degrees F heating by modulating the 2-way or 3-way (see mechanical details and schedules on the plans) chilled water valves and the 2-way hot water valve in sequence.

E. An IAQ sensor located in the pure return air stream shall modulate the outside air damper to maintain a setpoint of 800ppm.

A. When the unit fan is deenergized, the automatic control system shall be inoperable, and the Outside air damper, chilled water valve, and the hot water valve shall be closed to the coil.

G. All analog and digital inputs and outputs shall be displayed at the BAS.

3.4 VARIABLE AIR VOLUME BOXES (VAV BOXES)

A. Each VAV box shall be controlled by its own terminal equipment controller. The terminal equipment controller shall modulate the supply air damper or electric reheat coil as required to maintain temperature setpoint. The supply air volume will be limited by the minimum and maximum air volume settings.

B. When commanded to change over to the Unoccupied Mode, the terminal equipment controller shall raise the cooling setpoint and decrease the heating setpoint as required.

C. During the Unoccupied Mode, the terminal equipment controller shall be reset to Occupied Mode for an operator determined time period. This reset shall be activated by a signal from a local override switch on each room temperature sensor or by command from the operator's terminal. If each room sensor does not include this override switch capacity, an override switch shall be provided and installed at each room sensor location. At the end of the operator determined time period, the terminal equipment controller shall return to the Unoccupied Mode.

A. All parameters (minimum/maximum velocity setpoint, space temperature) shall be obtainable and updated from the operator's terminal by plugging into the local thermostat. In addition, all this information shall be obtainable and undated at the BAS terminal.

3.5 EXHAUST FANS

A. A manual reset high limit thermostat set at 125 degrees F shall de-energize all fans above 600CFM on a temperature rise above setpoint.

3.6 LIGHTING CONTROL

A. A total of twelve (12) lighting control points shall be provided to provide for scheduled start-stop

of the designated lighting circuits. Refer to the electrical drawings for panel locations and details.

END OF SECTION 15950