SECTION 23 09 23
DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 – GENERAL

1.1 DESCRIPTION

A. The control system(s) shall be as indicated on the project documents, point list, drawings and described in these specifications. This scope of work shall include a complete and working system including all engineering, programming, controls and installation materials, installation labor, commissioning and start-up, training, final project documentation and warranty.

B. Engineering Control Center (ECC) shall include:

   1. Operator Workstation Web-Browser User Interface (UI).

   2. Ethernet, IP Supervisory Network.

   3. Graphic Operational Interface.

   4. Software Configuration Tools (SCT).

   5. Scheduling and Alarm Management software.

   6. Local LonWorks FTT-10 or 1250 networks.

   7. Network Area Controllers (NAC).

   8. Data and File Server (DFS).

   9. Unitary Control Units (UCU).

   10. LonMark Compliant Application Controllers and field devices.

   11. Connected I/O devices.

   12. Third party system Data Integration.

C. The Controls Contractor's work shall include all labor, materials, special tools, equipment, enclosures, power supplies, software, software licenses, Project specific software configurations and database entries, interfaces, wiring, tubing, installation, labeling, engineering, calibration, documentation, submittals, testing, verification, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, Warranty, specified services and items required by the Contract for the complete and fully functional Controls Systems.

D. Following control devices and systems shall be used to provide the functional requirements of HVAC equipment and systems.

   1. Direct Digital Control (DDC) of HVAC equipment and systems with electric or electronic positioning of valves and dampers.

   2. Terminal units including terminal reheat coils and similar units for control of room environment conditions may be equipped with integral

controls furnished and installed by the equipment manufacturer or field mounted. Refer to equipment specifications and as indicated in project documents.

E. Base bid includes the installation of new DDC controls.

F. Connect the new work to the existing ECC system in building 18 via new ethernet connection, new software, manufactured by Siemens. Main ECC is located in Chiller Plant. Building 35.

G. The control subcontractor shall supply as required, all necessary hardware equipment and software packages to interface between any existing and new system Network Area Controllers (NAC) as part of this contract. Number of area controllers required is dependent on the type and quantity of devices, hardware and software points provided. Network area controllers are same as remote controller units (RCU).

H. The control systems shall be designed such that each mechanical system shall operate under stand-alone mode. Temperature Controls contractor shall provide controllers for each mechanical system. In the event of a network communication failure, or the loss of any other controller, the control system shall continue to operate independently. Failure of the ECC shall have no effect on the field controllers, including those involved with global strategies.

I. The Top End of the NAC shall communicate using American Society of Heating and Refrigerating Engineers/American National Standards Institute (ASHRAE/ANSI) Standard 135(BACnet) protocol. The NAC shall reside on the BACnet/IP Ethernet (ISO 8802-3) local area network, and provide information via standard BACnet object types and application services. The Bottom End of the NAC, the unit level controllers and all other field devices shall reside on the LonTalk FTT-10a network, and provide data using LonMark standard network variable types and configuration properties.

J. The intent of this specification is to provide a peer-to peer networked, stand-alone, distributed control system. The ECC 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 (NAC) Network Area Controllers, Remote Control Unit controllers, unitary terminal unit controllers and other LonMark compliant field devices. The minimum Baud rate shall be 78,000 Baud for FTT-10 and 1,250,000 Baud for FTT-1250.

    1. LonTalk communications protocol will be used on the communication network between RCU controllers and LonWorks controllers and devices to assure interoperability between all devices within the network.

    2. The ECC shall provide communication to all LonTalk data variables as defined in input/output point schedule and as required to accomplish sequence of operation as specified.

    3. Power wiring shall not be run in conduit with communications trunk wiring or signal or control wiring operating at 100 volts or less.

K. The control system shall accommodate 5 users simultaneously, and the access to the system should be limited only by operator password as through the main building ECC system as manufactured the existing base building system. Provide new ECC software to tie into existing, all systems shall be compatible.

1.2 RELATED WORK

A. Section 28 31 00, FIRE DETECTION AND ALARM.

B. Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.

C. Section 23 21 13, HYDRONIC PIPING and Section 23 22 13, STEAM AND CONDENSATE HEATING PIPING.

D. Section 23 31 00, HVAC DUCTS AND CASINGS.

E. Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.

F. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

G. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS.

H. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW).

I. Section 26 27 26, WIRING DEVICES.

1.3 DEFINITION

A. Algorithm: A logical procedure for solving a recurrent mathematical problem; A prescribed set of well-defined rules or processes for the solution of a problem in a finite number of steps.

B. ACU: Auxiliary Control Unit (ACU) used for controls of air handling units, reports to RCU.

C. Analog: A continuously varying signal value (e.g., temperature, current, velocity etc.

D. BACnet: Building Automation Control Network Protocol, ASHRAE Standard 135.

E. Baud: It is a signal change in a communication link. One signal change can represent one or more bits of information depending on type of transmission scheme. Simple peripheral communication is normally one bit per Baud. (e.g., Baud rate = 78,000 Baud/sec is 78,000 bits/sec, if one signal change = 1 bit).

F. Binary: A two-state system where a high signal level represents an "ON" condition and an "OFF" condition is represented by a low signal level.

G. BMP or bmp: Suffix, computerized image file, used after the period in a DOS-based computer file to show that the file is an image stored as a series of pixels.

H. Bus Topology: A network topology that physically interconnects workstations and network devices in parallel on a network segment.

I. Control Unit (CU): Generic term for any controlling unit, stand-alone, microprocessor based, digital controller residing on secondary LAN or Primary LAN, used for local controls or global controls. In this specification, there are three types of control units are used; Unitary Control Unit (UCU), Auxiliary Control Unit (ACU), and Remote Control Unit (RCU).

J. Deadband: A temperature range over which no heating or cooling is supplied, i.e., 22-25 degrees C (72-78 degrees F), as opposed to a single point change over or overlap).

K. Diagnostic Program: A software test program, which is used to detect and report system or peripheral malfunctions and failures. Generally, this system is performed at the initial startup of the system.

L. Direct Digital Control (DDC): Microprocessor based control including Analog/Digital conversion and program logic. A control loop or subsystem in which digital and analog information is received and processed by a microprocessor, and digital control signals are generated based on control algorithms and transmitted to field devices in order to achieve a set of predefined conditions.

M. Distributed Control System: A system in which the processing of system data is decentralized and control decisions can and are made at the subsystem level. System operational programs and information are provided to the remote subsystems and status is reported back to the Engineering Control Center. Upon the loss of communication with the Engineering Control center, the subsystems shall be capable of operating in a stand-alone mode using the last best available data.

N. Download: The electronic transfer of programs and data files from a central computer or operation workstation with secondary memory devices to remote computers in a network (distributed) system.

O. DXF: An AutoCAD 2-D graphics file format. Many CAD systems import and export the DXF format for graphics interchange.

P. Electrical Control: A control circuit that operates on line or low voltage and uses a mechanical means, such as a temperature sensitive bimetal or bellows, to perform control functions, such as actuating a switch or positioning a potentiometer.

Q. Electronic Control: A control circuit that operates on low voltage and uses a solid-state components to amplify input signals and perform control functions, such as operating a relay or providing an output signal to position an actuator.

R. Engineering Control Center (ECC): The centralized control point for the intelligent control network. The ECC comprises of personal computer and connected devices to form a single workstation.

S. Ethernet: A trademark for a system for exchanging messages between computers on a local area network using coaxial, fiber optic, or twisted-pair cables.

T. Firmware: Firmware is software programmed into read only memory (ROM) chips. Software may not be changed without physically altering the chip.

U. FTT-10: Echelon Transmitter-Free Topology Transceiver.

V. GIF: Abbreviation of Graphic interchange format.

W. Graphic Program (GP): Program used to produce images of air handler systems, fans, chillers, pumps, and building spaces. These images can be animated and/or color-coded to indicate operation of the equipment.

X. Graphic Sequence of Operation: It is a graphical representation of the sequence of operation, showing all inputs and output logical blocks.

Y. I/O Unit: The section of a digital control system through which information is received and transmitted. I/O refers to analog input (AI, digital input (DI), analog output (AO) and digital output (DO). Analog signals are continuous and represent temperature, pressure, flow rate etc, whereas digital signals convert electronic signals to digital pulses (values), represent motor status, filter status, on-off equipment etc.

Z. I/P: Internet Protocol-global network, connecting workstations and other host computers, servers etc. to share the information.

AA. JPEG: A standardized image compression mechanism stands for Joint Photographic Experts Group, the original name of the committee that wrote the standard.

BB. Local Area Network (LAN): A communication bus that interconnects operator workstation and digital controllers for peer-to-peer communications, sharing resources and exchanging information.

CC. LonMark: An association comprising of suppliers and installers of LonTalk products. The Association provides guidelines for the implementation of the LonTalk protocol to ensure interoperability through Standard implementation.

DD. LonTalk: An open standard protocol developed by the Echelon Corporation that uses a "Neuron Chip" for communication.

EE. LonWorks: Network technology developed by the Echelon Corporation.

FF. Network: A set of computers or other digital devices communicating with each other over a medium such as wire, coax, fiber optics cable etc.

GG. Network Area Controller: Digital controller, supports a family of auxiliary control units and unitary control units, and communicates with peer-to-peer network for transmission of global data.

HH. Network Repeater: A device that receives data packet from one network and rebroadcasts to another network. No routing information is added to the protocol.

II. MS/TP: Master-slave/token-passing.

JJ. Operating system (OS): Software, which controls the execution of computer application programs.

KK. PCX: File type for an image file. When photographs are scanned onto a personal computer they can be saved as PCX files and viewed or changed by a special application program as Photo Shop.

LL. Peripheral: Different components that make the control system function as one unit. Peripherals include monitor, printer, and I/O unit.

MM. Peer-to-Peer: A networking architecture that treats all network stations as equal partners.

NN. PICS: Protocol Implementation Conformance Statement.

OO. UCU: Unitary Control Unit, digital controller, dedicated to a specific piece of equipment, such as VAV boxes, chillers, fan coil units, heat exchangers etc.

1.4 QUALITY ASSURANCE

  A. Criteria:

    1. The Controls and Instrumentation System Contractor shall be a primary equipment manufacturer-owned branch office that is regularly engaged in the engineering, programming, installation and service of total integrated Facility Management Systems of similar size, scope and complexity to the EEC specified in this Contract. Distributors, manufacturer's representatives and wholesalers will not be acceptable.

    2. Single Source Responsibility of subcontractor: The Contractor shall obtain hardware and software supplied under this Section and delegates the responsibility to a single source controls installation subcontractor. The controls subcontractor shall be responsible for the complete design, installation, and commissioning of the system. The controls subcontractor shall be in the business of design, installation and service of such building automation control systems similar in size and complexity. This contractor shall be responsible for integration of all new software into existing control network.

    3. Equipment and Materials: Equipment and materials shall be cataloged products of manufacturers regularly engaged in production and installation of HVAC control systems. Products shall be manufacturer's latest standard design and have been tested and proven in actual use.

    4. The controls subcontractor shall provide a list of no less than five similar projects which have building control systems as specified in this Section. These projects must be on-line and functional such that the Department of Veterans Affairs (VA) representative would observe the control systems in full operation.

    5. The controls subcontractor shall have (minimum of three years) experience in design and installation of building automation systems similar in performance to those specified in this Section. Provide evidence of experience by submitting resumes of the project manager, the local branch manager, project engineer, the application engineering staff, and the electronic technicians who would be involved with the supervision, the engineering, and the installation of the control systems. Training and experience of these personnel

    shall not be less than three years. Failure to disclose this
    information will be a ground for disqualification of the supplier.

  6. The controls subcontractor shall have in-place facility within 50
    miles with technical staff, spare parts inventory for the next five
    (5) years, and necessary test and diagnostic equipment to support
    the control systems.

  7. Provide a competent and experienced Project Manager employed by the
    Controls Contractor. The Project Manager shall be supported as
    necessary by other Contractor employees in order to provide
    professional engineering, technical and management service for the
    work. The Project Manager shall attend scheduled Project Meetings as
    required and shall be empowered to make technical, scheduling and
    related decisions on behalf of the Controls Contractor.

 B. Codes and Standards:

  1. All work shall conform to the applicable Codes and Standards.

  2. Electronic equipment shall conform to the requirements of FCC
    Regulation, Part 15, Governing Radio Frequency Electromagnetic
    Interference, and be so labeled.

  3. Peer-to-peer controllers, unitary controllers shall conform to the
    requirements of UL 916, Category PAZX.

1.5 PERFORMANCE

 A. The system shall conform to the following:

  1. Graphic Display: The system shall display up to 4 graphics on a
    single screen with a minimum of (20) dynamic points per graphic. All
    current data shall be displayed within (10) seconds of the request.

  2. Graphic Refresh: The system shall update all dynamic points with
    current data within (10) seconds. Data refresh shall be automatic,
    without operator intervention.

  3. Object Command: The maximum time between the command of a binary
    object by the operator and the reaction by the device shall be (10)
    seconds. Analog objects shall start to adjust within (3) seconds.

  4. Object Scan: All changes of state and change of analog values shall
    be transmitted over the high-speed network such that any data used
    or displayed at a controller or work-station will be current, within
    the prior (10) seconds.

  5. Alarm Response Time: The maximum time from when an object goes into
    alarm to when it is annunciated at the workstation shall not exceed
    (10) seconds.

6. Program Execution Frequency: Custom and standard applications shall be capable of running as often as once every (5) seconds. The Contractor shall be responsible for selecting execution times consistent with the mechanical process under control.

7. Performance: Programmable Controllers shall be able to execute DDC PID control loops at a selectable frequency from at least once every five (5) seconds. The controller shall scan and update the process value and output generated by this calculation at this same frequency.

8. Multiple Alarm Annunciations: All workstations on the network shall receive alarms within (5) seconds of each other.

9. Reporting Accuracy: Listed below are minimum acceptable reporting accuracies for all values reported by the specified system:

Measured Variable	Reported Accuracy
Space temperature	±0.5 degrees C (±1 degrees F)
Ducted air temperature	±1.0 degrees C [±2 degrees F]
Outdoor air temperature	±1.0 degrees C [±2 degrees F]
Water temperature	±0.5 degrees C [±1 degrees F]
Relative humidity	±2 percent RH
Water flow	±5 percent of full scale
Air flow (terminal)	±10 percent of reading
Air flow (measuring stations)	±5 percent of reading
Air pressure (ducts)	±25 Pa [±0.1 "W.G.]
Air pressure (space)	±3 Pa [±0.001 "W.G.]
Water pressure	±2 percent of full scale *Note 1
Electrical Power	5 percent of reading

Note 1: for both absolute and differential pressure

1.6 WARRANTY

A. Labor and materials for control systems shall be warranted for a period as specified under Warranty in FAR clause 52.246-21.

B. Control system failures during the warranty period shall be adjusted, repaired, or replaced at no cost or reduction in service to the owner. The system includes all computer equipment, transmission equipment, and all sensors and control devices.

C. The on-line support service shall allow the Controls supplier to dial out over telephone lines to monitor and control the facility's building automation system. This remote connection to the facility shall be within two (2) hours of the time that the problem is reported. This coverage shall be extended to include normal business hours, after business hours, weekend and holidays. If the problem cannot be resolved with on-line support services, the Controls supplier shall dispatch the qualified personnel to the job site to resolve the problem within 24 hours after the problem is reported.

D. Controls and Instrumentation subcontractor shall be responsible for temporary operations and maintenance of the control systems during the construction period until final commissioning, training of facility operators and acceptance of the project by VA.

1.7 SUBMITTALS

A. Submit shop drawings in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Manufacturer's literature and data for all components including the following:

1. A wiring diagram for each type of input device and output device including DDC controllers, modems, repeaters, etc. Diagram shall show how the device is wired and powered, showing typical connections at the digital controllers and each power supply, as well as the device itself. Show for all field connected devices, including but not limited to, control relays, motor starters, electric or electronic actuators, and temperature pressure, flow and humidity sensors and transmitters.

2. A diagram of each terminal strip, including digital controller terminal strips, terminal strip location, termination numbers and the associated point names.

3. Control dampers and control valves schedule, including the size and pressure drop.

4. Installation instructions for smoke dampers and combination smoke/fire dampers, if furnished.

5. Catalog cut sheets of all equipment used. This includes, but is not limited to DDC controllers, panels, peripherals, airflow measuring stations and associated components, and auxiliary control devices such as sensors, actuators, and control dampers. When manufacturer's cut sheets apply to a product series rather than a specific product,

the data specifically applicable to the project shall be highlighted. Each submitted piece of literature and drawings should clearly reference the specification and/or drawings that it supposed to represent.

6. Sequence of operations for each HVAC system and the associated control diagrams. Equipment and control labels shall correspond to those shown on the drawings.

7. Color prints of proposed graphics with a list of points for display.

8. Furnish PICS for each BACNET compliant device.

C. Product Certificates: Compliance with Article, QUALITY ASSURANCE.

D. As Built Control Drawings:

1. Furnish three (3) copies of as-built drawings for each control system. The documents shall be submitted for approval prior to final completion.

2. Furnish one (1) stick set of applicable control system prints for each mechanical system for wall mounting. The documents shall be submitted for approval prior to final completion.

3. Furnish one (1) CD-ROM in CAD DWG and PDF format for the drawings noted in subparagraphs above.

E. Operation and Maintenance (O/M) Manuals):

1. Submit in accordance with Article, INSTRUCTIONS, in Specification Section 01 00 00, GENERAL REQUIREMENTS.

2. Include the following documentation:

a. General description and specifications for all components, including logging on/off, alarm handling, producing trend reports, overriding computer control, and changing set points and other variables.

b. Detailed illustrations of all the control systems specified for ease of maintenance and repair/replacement procedures, and complete calibration procedures.

c. Three copies of the final version of all software provided including operating systems, programming language, operator workstation software, and graphics software.

d. Complete troubleshooting procedures and guidelines for all systems.

e. Complete operating instructions for all systems.

f. Recommended preventive maintenance procedures for all system components including a schedule of tasks for inspection, cleaning

and calibration. Provide a list of recommended spare parts needed to minimize downtime.

g. Licenses, guaranty, and other pertaining documents for all equipment and systems.

h. Training Manuals: Submit the course outline and training material to the Owner for approval three (3) weeks prior to the training to VA facility personnel. These persons will be responsible for maintaining and the operation of the control systems, including programming. The Owner reserves the right to modify any or all of the course outline and training material.

F. Submit Performance Report to COR prior to final inspection.

1.8 INSTRUCTIONS

A. Instructions to VA operations personnel: Perform in accordance with Article, INSTRUCTIONS, in Specification Section 01 00 00, GENERAL REQUIREMENTS, and as noted below.

1. First Phase: Formal instructions to the VA facilities personnel for a total of 16 hours, conducted sometime between the completed installation and prior to the performance test period of the control system, at a time mutually agreeable to the Contractor and the VA.

2. Second Phase: This phase of training shall comprise of on the job training during start-up, checkout period, and performance test period. VA facilities personnel will work with the Contractor's installation and test personnel on a daily basis during start-up and checkout period. During the performance test period, controls subcontractor will provide 16 hours of instructions to the VA facilities personnel.

3. The O/M Manuals shall contain approved submittals as outlined in SUBMITTALS. The Controls subcontractor will review the manual contents with VA facilities personnel during second phase of training.

4. Training by independent or franchised dealers who are not direct employees of the controls supplier will not be acceptable.

1.9 PROJECT CONDITIONS (ENVIRONMENTAL CONDITIONS OF OPERATION)

A. The ECC and peripheral devices and system support equipment shall be designed to operate in ambient condition of 20 to 35 degrees C (65 to 90 degrees F) at a relative humidity of 20 to 80 percent non-condensing.

B. The CUs and associated equipment used in controlled environment shall
be mounted in NEMA 1 enclosures for operation at 0 to 50 degrees C (32
to 122 degrees F) at a relative humidity of 10 to 90 percent non-
condensing.

C. The CUs used outdoors shall be mounted in NEMA 4 waterproof enclosures,
and shall be rated for operation at -40 to 65 degrees C (-40 to 150
degrees F).

D. All electronic equipment shall operate properly with power fluctuations
of plus 10 percent to minus 15 percent of nominal supply voltage.

E. Sensors and controlling devices shall be designed to operate in the
environment, which they are sensing or controlling.

1.10 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the
extent referenced. The publications are referenced in the text by the
basic designation only.

B. American Society of Heating, Refrigerating, and Air-Conditioning
Engineers (ASHRAE):

Standard 135-04.........BACNET Building Automation and Control Networks

C. American Society of Mechanical Engineers (ASME):

B16.18-01...............Cast Copper Alloy Solder Joint Pressure
Fittings.

B16.22-01...............Wrought Copper and Copper Alloy Solder Joint
Pressure Fittings.

BPVC-CC-N-04............Boiler and Pressure Vessel Code

D. American Society of Testing Materials (ASTM):

B32-04..................Standard Specification for Solder Metal

B88-03..................Standard Specifications for Seamless Copper
Water Tube

B88M-05.................Standard Specification for Seamless Copper
Water Tube (Metric)

B280-03.................Standard Specification for Seamless Copper Tube
for Air-Conditioning and Refrigeration Field
Service

D2737-03...............Standard Specification for Polyethylene (PE)
Plastic Tubing

E. Federal Communication Commission (FCC):

Rules and Regulations Title 47 Chapter 1-2001 Part 15..Radio Frequency
Devices.

   F. Institute of Electrical and Electronic Engineers (IEEE):

      802.3-05.................Information Technology-Telecommunications and Information Exchange between Systems-Local and Metropolitan Area Networks- Specific Requirements-Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access method and Physical Layer Specifications

   G. Instrument Society of America (ISA):

      7.0.01-1996..............Quality Standard for Instrument Air

   H. National Fire Protection Association (NFPA):

      70-05....................National Electric Code

      90A-02..................Standard for Installation of Air-Conditioning and Ventilation Systems

   I. Underwriter Laboratories Inc (UL):

      94-06...................Tests for Flammability of Plastic Materials for Parts and Devices and Appliances

      294-05..................Access Control System Units

      486A/486B-04-...........Wire Connectors

      555S-03.................Standard for Smoke Dampers

      916-Rev 2-04............Energy Management Equipment

      1076-05.................Proprietary Burglar Alarm Units and Systems

PART 2 – PRODUCTS

2.1 CONTROLS SYSTEM ARCHITECTURE

   A. General

      1. The Controls Systems shall consist of multiple Nodes and associated equipment connected by industry standard digital and communication network arrangements.

      2. The Operator Workstations, Servers and principal network computer equipment shall be standard products of recognized major manufacturers available through normal PC and computer vendor channels – not "Clones" assembled by a third-party subcontractor.

      3. Provide licenses for all software residing on and used by the Controls Systems and transfer these licenses to the Owner prior to completion.

      4. The networks shall, at minimum, comprise, as necessary, the following:

         a. Operator Workstations – fixed and portable as required by the Specifications.

b. Network computer processing, data storage and communication equipment including Servers and digital data processors.

c. Routers, bridges, switches, hubs, modems, interfaces and the like communication equipment.

d. Active processing network area controllers connected to programmable field panels and controllers together with their power supplies and associated equipment.

e. Addressable elements, sensors, transducers and end devices.

f. Third-party equipment interfaces as required by the Contract Documents.

g. Other components required for a complete and working Control Systems as specified.

B. The Specifications for the individual elements and component subsystems shall be minimum requirements and shall be augmented as necessary by the Contractor to achieve both compliance with all applicable codes, standards and to meet all requirements of the Contract Documents.

C. Network Architecture

1. The Controls Systems Application network shall utilize an open architecture capable of each and all of the following:

   a. Utilizing standard Ethernet communications and operate at a minimum speed of 10/100 Mb/sec.

   b. Connecting via BACNET with ANSI/ASHRAE Standard 135.

   c. LonMark as per ANSI/EIA 709 (LonWorks) to LonMark FTT-10 transceivers.

2. The networks shall utilize only copper and optical fiber communication media as appropriate and shall comply with applicable codes, ordinances and regulations. They may also utilize digital wireless technologies if required by the VA.

3. All necessary telephone lines, ISDN lines and internet Service Provider services and connections will be provided by the owner.

4. The Controls Contractor shall provide all IT interfacing equipment and cabling to a detail coordinated with the Owner.

D. Third Party Interfaces:

1. The Controls Systems shall include necessary hardware, equipment and software to allow data communications between the Controls Systems and building systems supplied by other trades. Remote access may not be used during the construction phase of this project and all

installation work shall be bid based on work at the actual VA
campus.

    2. The other manufacturers and contractors supplying other associated
systems and equipment will provide their necessary hardware,
software and start-up at their cost and will cooperate fully with
the Controls Contractor in a timely manner and at their cost to
ensure complete functional integration.

  E. Servers:

    1. Provide Controls Systems Application Server(s) to archive historical
data including trends, alarm and event histories and transaction
logs.

    2. Equip these Server(s) with the same software Tool Set that is
located in the Network Area Controllers for system configuration and
custom logic definition and color graphic configuration.

    3. Access to all information on the Controls Systems Server(s) shall be
through the same browser Operator Interface functionality used to
access individual nodes. When logged onto a Server the Operator will
be able to also interact with any other NAC on the Controls As
required for the functional operation of the Controls Systems, the
Controls Contractor shall provide all necessary digital processor
programmable Server(s). These Server(s) shall be utilized for
Controls Systems Application configuration, for archiving, reporting
and trending of data, for Operator transaction archiving and
reporting, for network information management, for alarm
annunciation, for Operator Interface tasks, for Controls Application
management and the like. These Server(s) shall utilize IT industry
standard data base platforms such as Microsoft SQL Server and
Microsoft Data Engine (MSDE) or approved equal.

2.2 DIRECT DIGITAL CONTROLLERS

  A. (NAC) Network Area Controllers shall be stand-alone, multi-tasking,
multi-user, real-time digital processor complete with all hardware,
software, and communications interfaces, power supplies. The Controls
System shall be designed and implemented entirely for use and operation
on the Internet. NACs shall have access to data within the industry
standard IT network to the Data Server and other NACs as needed to
accomplish required global control strategies.

    1. NACs shall provide both standalone and networked direct digital
control of mechanical and electrical building system controllers as

required by the Specifications. The primary NAC shall support a minimum of [5,000] field points together with all associated features, sequences, schedules, applications required for a fully functional distributed processing operation.

2. NACs shall monitor and report communication status to the Controls Systems Application. The Controls Systems shall provide a system advisory upon communication failure and restoration.

3. All NACs on the network shall be equipped with all software functionality necessary to operate the complete user interface, including graphics, via a Browser connected to the Node on the network or directly via a local port on the NAC.

4. All NAC shall be provided with face mounted LED type annunciation to continually display its operational mode, power and communications.

5. The controllers shall reside on the BACnet Ethernet (ISO 8802-3) local area network and provide Read (Initiate) and Write (Execute) services as defined in Clauses 15.5 and 15.8, respectively of ASHRAE Standard 135, to communicate BACnet objects. Objects supported shall include: Analog input, analog output, analog value, binary input, binary output, binary value, and device.

6. Each NAC shall be provided with the necessary un-interruptible power facilities to ensure its continued normal operation during periods of line power outages of, at minimum, 1-minute duration. Normal functionality shall include all normal software processing, communication with powered field devices and network communications with other powered Controls Systems NAC, Data Servers and OWS. Each NAC shall report its communication status to the Application. The Application shall provide a system advisory upon communication failure and restoration. Each NAC shall retain program, control algorithms, and setpoint information in non-volatile memory in the event of a power failure, and shall return to normal operation upon restoration of power.

7. Each NAC shall have sufficient memory to support its operating system, database, and program requirements, including the following:
   a. Device and network management.
   b. Data sharing.
   C. Alarm and event management including custom alarm messages for each level alarm for the points noted in the I/O Schedule.
   d. Energy management.

      e. Historical trend data for points specified.

      f. Maintenance report.

      g. Scheduling.

      h. Dial up and network communications.

      i. Manual override monitoring.

8. Each NAC shall support firmware upgrades without the need to replace hardware and shall have a minimum of 15 percent spare capacity of secondary system controllers, point capacity and programming functions.

9. Each NAC shall continuously perform self-diagnostics, communication diagnosis, and provide both local and remote annunciation of any detected component failures, low battery condition; and upon failure shall assume the predetermined failure mode.

10. Each NAC shall monitor the status of all overrides and inform the operator that automatic control has inhibited, and allow the operator to manually override automatic or centrally executed command.

11. Provide the capability to generate and modify the Controls Systems Application software-based sequences, database elements, associated operational definition information and user-required revisions to same at any designated Workstation together with the means to download same to the associated System Controllers.

12. In the event of loss of normal power, there shall be orderly shut down of the controllers to prevent the loss of database or software programming. When power is restored flash memory, battery backup or super capacitor will be automatically loaded into non-volatile flash memory and shall be incorporated for all programming data.

B. Auxiliary Control Units (ACUs) shall be stand-alone, multi-tasking, multi-user, real time digital processor complete with all hardware, software and communication interfaces, power supplies, and input/output modular devices.

1. ACUs shall either reside on the LonTalk FTT-10a network or provide data using LonMark standard network variable types and configuration properties.

2. All ACUs shall be provided with LED type annunciation to continually display its operational mode, power and communications.

3. Each ACU shall have sufficient memory to support its operating system, database including the following:

        a. Data sharing.

        b. Device and network management.

        c. Alarm and event management.

        d. Scheduling.

        e. Energy Management.

4. Each ACU shall support firmware upgrades without the need to replace hardware and shall have a minimum of 15 percent spare capacity of I/O functions. The type of spares shall be in the same proportion as the implemented functions on the controller, but in no case there shall be less than one point of each implemented I/O type.

5. Each ACU shall continuously perform self-diagnostics, communication diagnosis, and provide both local and remote annunciation of any detected component failures, low battery condition; and upon failure shall assume the predetermined failure mode.

6. In the event of loss of normal power, there shall be orderly shut down of the controllers to prevent the loss of database or software programming. When power is restored flash memory, battery backup or super capacitor will be automatically loaded into non-volatile flash memory and shall be incorporated for all programming data.

C. Unitary Control Units (UCUs) shall be microprocessor-based. They shall be capable of stand-alone operation, continuing to provide stable control functions if communication is lost with the rest of the system.

1. Unitary Control Units shall either reside on the LonTalk FTT-10a network or provide data using LonMark standard network variable types and configuration properties.

2. Each UCU shall have sufficient memory to support its own operating system, including data sharing.

3. All UCUs shall be provided with LED type annunciation to continually display its operational mode, power and communications.

4. In the event of loss of normal power, there shall be orderly shut down of the controllers to prevent the loss of database or software programming. When power is restored flash memory, battery backup or super capacitor will be automatically loaded into non-volatile flash memory and shall be incorporated for all programming data.

D. Provide I/O module that connects sensors and actuators onto the field bus network for use by the direct digital controllers. I/O devices shall support the communication technology specified for each controller.

1. Analog input shall allow the monitoring of low voltage (0-10 VDC), current (4-20 ma), or resistance signals (thermistor, RTD). Analog input shall be compatible with, and field configurable to commonly available sensing devices. Analog output shall provide a modulating signal for these control devices.

2. Binary inputs shall allow the monitoring of on/off signals from remote devices. Binary inputs shall provide a wetting current of at least 12 milliamps to be compatible with commonly available control devices. Binary outputs shall provide on/off operation, or a pulsed low voltage signal for pulse width modulation control. Outputs shall be selectable for either normally open or normally closed operation.

3. Binary outputs on remote and auxiliary controllers shall have 3-position (on/off/auto) override switches and status lights. Analog outputs on remote and auxiliary controllers shall have status lights and a 2-position (auto/manual) switch and manually adjustable potentiometer for manual override.

4. Each output point shall be provided with a light emitting diode (LED) to indicate status of outputs.

E. Communication Ports:

1. NACs controllers in the DDC systems shall be connected in a system local area network using protocol defined by ASHRAE Standard 135, BACnet protocol.

2. The control supplier shall provide connectors, repeaters, hubs, and routers necessary for inter-network communication.

3. Minimum baud rate between the peer-to-peer controllers in the system LAN shall be maintained at the rate of 10 Mbps. Minimum baud for the low level controllers between UCUs and ACUs, ACUs and NAC's shall be maintained at the rate of 76 Kbps.

4. Provide RS-232 port with DB-9 or RJ-11 connector for communication with each controller that will allow direct connection of standard printers, operator terminals, modems, and portable laptop operator's terminal. Controllers shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers or terminals.

5. Database, such as points; status information, reports, system software, custom programs of any one controller shall be readable by any other controller on the network.

    F. Diagnostic Devices (DD):

       1. Provide a laptop computer capable of accessing all system data. This device may be connected to any point on the system network or may be connected directly to any digital controller for programming, set-up, and troubleshooting.

       2. Laptop computer shall be PC notebook style containing necessary software and hardware required. The PC shall contain as a minimum:

          a. 2.4 GHZ Intel Pentium Processor.

          b. 128MB, 100 MHz RAM.

          c. 60GB Hard Drive.

          d. One-Die 256K L2 Cache.

          e. 3.5 inch, 1.44MB Floppy Disk Drive

          f. 48 X CD RW Drive.

          g. 56K Internal Modem.

          h. 32MB video memory graphics.

          i. Ethernet IP network card.

          j. Operating system compatible with PC Microsoft XP professional listed under Operator Workstation.

    G. Electric Outlet: Provide a single phase, 120 VAC electrical receptacle, a telephone port and Ethernet port inside or within 2 meters (6 feet) of the NAC and ACU enclosures for use with test equipment.

    H. Spare Equipment:

       1. Provide spare digital controller (CU) boards and spare I/O boards as required. It shall be possible for trained hospital personnel to replace CU boards and load software via the Laptop computer or the ECC.

       2. Provide a minimum of one spare digital controller board of each type and associated parts including batteries to make at least one complete set of DDC control equipment spares.

       3. If I/O boards are separate from the CU boards, provide two spare I/O boards for each spare CU board provided above.

2.3 DIRECT DIGITAL CONTROLLER SOFTWARE

    A. The software programs specified in this section shall be commercially available, concurrent, multi-tasking operating system and support the use of software application that operates under DOS or Microsoft Windows. All software shall be compatible with existing control system hardware for the campus and shall be able to integrate the new and

existing units communicating over the Ethernet into a single control package.

B. All points shall be identified by up to 30-character point name and 16-character point descriptor. The same names shall be used at the operator workstation.

C. All control functions shall execute within the stand-alone control units via DDC algorithms. The VA shall be able to customize control strategies and sequences of operations defining the appropriate control loop algorithms and choosing the optimum loop parameters.

D. All CU's shall be capable of being programmed to utilize stored default values for assured fail-safe operation of critical processes. Default values shall be invoked upon sensor failure or, if the primary value is normally provided by the central or another CU, or by loss of bus communication. Individual application software packages shall be structured to assume a fail-safe condition upon loss of input sensors. Loss of an input sensor shall result in output of a sensor-failed message at the ECC workstation. Each ACU and RCU shall have capability for local readouts of all functions. The UCUs shall be read remotely.

E. All DDC control loops shall be able to utilize any of the following control modes:

1. Two position (on-off, slow-fast) control.

2. Proportional control.

3. Proportional plus integral (PI) control.

4. Proportional plus integral plus derivative (PID) control. All PID programs shall automatically invoke integral wind up prevention routines whenever the controlled unit is off, under manual control of an automation system or time initiated program.

5. Automatic tuning of control loops.

F. System Security: Operator access shall be secured using individual password and operator's name. Passwords shall restrict the operator to the level of object, applications, and system functions assigned to him. A minimum of six (6) levels of security for operator access shall be provided.

G. Application Software: The CUs shall provide the following programs as a minimum for the purpose of optimizing energy consumption while maintaining comfortable environment for occupants. All application software shall reside and run in the system digital controllers. Editing of the application shall occur at the operator workstation or

via a portable workstation, when it is necessary, to access directly
the programmable unit.

1. Power Demand Limiting (PDL): Power demand limiting program shall
   monitor the building power consumption and limit the consumption of
   electricity to prevent peak demand charges. PDL shall continuously
   track the electricity consumption from a pulse input generated at
   the kilowatt-hour/demand electric meter. PDL shall sample the meter
   data to continuously forecast the electric demand likely to be used
   during successive time intervals. If the forecast demand indicates
   that electricity usage will likely to exceed a user preset maximum
   allowable level, then PDL shall automatically shed electrical loads.
   Once the demand load has met, loads that have been shed shall be
   restored and returned to normal mode. Control system shall be
   capable of demand limiting by resetting the HVAC system set points
   to reduce load while maintaining indoor air quality.

2. Economizer: An economizer program shall be provided for air systems.
   This program shall control the position of air handler relief,
   return, and outdoors dampers. If the outdoor air dry bulb
   temperature falls below changeover set point the energy control
   center will modulate the dampers to provide 100 percent outdoor air.
   The operator shall be able to override the economizer cycle and
   return to minimum outdoor air operation at any time.

3. Night Setback/Morning Warm up Control: The system shall provide the
   ability to automatically adjust set points for this mode of
   operation.

4. Optimum Start/Stop (OSS): Optimum start/stop program shall
   automatically be coordinated with event scheduling. The OSS program
   shall start HVAC equipment at the latest possible time that will
   allow the equipment to achieve the desired zone condition by the
   time of occupancy, and it shall also shut down HVAC equipment at the
   earliest possible time before the end of the occupancy period and
   still maintain desired comfort conditions. The OSS program shall
   consider both outside weather conditions and inside zone conditions.
   The program shall automatically assign longer lead times for weekend
   and holiday shutdowns. The program shall poll all zones served by
   the associated AHU and shall select the warmest and coolest zones.
   These shall be used in the start time calculation. It shall be
   possible to assign occupancy start times on a per air handler unit

basis. The program shall meet the local code requirements for minimum outdoor air while the building is occupied. Modification of assigned occupancy start/stop times shall be possible via operator's workstation.

5. Event Scheduling: Provide a comprehensive menu driven program to automatically start and stop designated points or a group of points according to a stored time. This program shall provide the capability to individually command a point or group of points. When points are assigned to one common load group it shall be possible to assign variable time advances/delays between each successive start or stop within that group. Scheduling shall be calendar based and advance schedules may be defined up to one year in advance. Advance schedule shall override the day-to-day schedule. The operator shall be able to define the following information:

   a. Time, day.

   b. Commands such as on, off, auto.

   c. Time delays between successive commands.

   d. Manual overriding of each schedule.

   e. Allow operator intervention.

6. Alarm Reporting: The operator shall be able to determine the action to be taken in the event of an alarm. Alarms shall be routed to the appropriate workstations based on time and events. An alarm shall be able to start programs, login the event, print and display the messages. The system shall allow the operator to prioritize the alarms to minimize nuisance reporting and to speed operator's response to critical alarms. A minimum of six (6) priority levels of alarms shall be provided for each point.

7. Remote Communications: The system shall have the ability to dial out in the event of an alarm to 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. Remote access shall allow the operator to function the same as local access.

8. Maintenance Management (PM): The program shall monitor equipment status and generate maintenance messages based upon the operators defined equipment run time, starts, and/or calendar date limits. A preventative maintenance alarm shall be printed indicating

maintenance requirements based on pre-defined run time. Each
preventive message shall include point description, limit criteria
and preventative maintenance instruction assigned to that limit. A
minimum of 480-character PM shall be provided for each component of
units such as air handling units.

2.4 SENSORS (AIR, WATER AND STEAM)

A. Temperature and Humidity Sensors:

1. Electronic Sensors: Provide all remote sensors as required for the
systems. All sensors shall be vibration and corrosion resistant for
wall, immersion, and/or duct mounting.

a. Temperature Sensors: Thermistor type for terminal units and
Resistance Temperature Device (RTD) with an integral transmitter
type for all other sensors.

1) Duct sensors shall be rigid or averaging type as shown on
drawings. Averaging sensor shall be a minimum of 1 linear ft
of sensing element for each sq ft of cooling coil face area.

2) Immersion sensors shall be provided with a separable well made
of stainless steel, bronze or monel material. Pressure rating
of well is to be consistent with the system pressure in which
it is to be installed.

3) Space sensors shall be equipped with set-point adjustment,
override switch, display, and/or communication port as shown
on the drawings. Match room thermostats, locking cover.

4) Outdoor air temperature sensors shall have watertight inlet
fittings and be shielded from direct sunlight.

5) Room security sensors shall have stainless steel cover plate
with insulated back and security screws.

6) Wire: Twisted, shielded-pair cable.

7) Output Signal: 4-20 ma.

b. Static Pressure Sensors: Non-directional, temperature
compensated.

1) 4-20 ma output signal.

2) 0 to 5 inches wg for duct static pressure range.

3) 0 to 0.25 inch wg for Building static pressure range.

B. Water Flow Sensors:

1. Sensor shall be insertion turbine type with turbine element,
retractor and preamplifier/transmitter mounted on a two-inch full
port isolation valve; assembly easily removed or installed as a

single unit under line pressure through the isolation valve without
interference with process flow; calibrated scale shall allow precise
positioning of the flow element to the required insertion depth
within plus or minute 1 mm (0.05 inch); wetted parts shall be
constructed of stainless steel. Operating power shall be nominal 24
VDC. Local instantaneous flow indicator shall be LED type in NEMA 4
enclosure with 3-1/2 digit display, for wall or panel mounting.

   2. Performance characteristics:
      a. Ambient conditions: -40 to 60 degrees C (-40 to 140 degrees F), 5
         to 100 percent humidity.
      b. Operating conditions: 850 kPa (125 psig), 0 to 120 degrees C (30
         to 250 degrees F), 0.15 to 12 m per second (0.5 to 40 feet per
         second) velocity.
      c. Nominal range (turn down ratio): 10 to 1.
      d. Overall accuracy plus or minus one percent of reading.
      e. Repeatability: plus or minus 0.25 percent of reading.
      f. Preamplifier mounted on meter shall provide 4-20 ma divided pulse
         output or switch closure signal for units of volume or mass per a
         time base. Signal transmission distance shall be a minimum of
         1,800 meters (6,000 feet).
      g. Pressure Loss: Maximum 1 percent of the line pressure in line
         sizes above 100 mm (4 inches).
      h. Ambient temperature effects, less than 0.005 percent calibrated
         span per degree C (degree F) temperature change.
      i. RFI effect - flow meter shall not be affected by RFI.
      j. Power supply effect less than 0.02 percent of span for a
         variation of plus or minus 10 percent power supply.

  C. Steam Flow Sensor/Transmitter:
   1. Sensor: Vortex shedder incorporating wing type sensor and
      amplification technology for high signal-to-noise ratio, carbon
      steel body with 316 stainless steel working parts, 24 VDC power,
      NEMA 4 enclosure.
      a. Ambient conditions, -40 to 80 degrees C (-40 to 175 degrees F).
      b. Process conditions, 900 kPa (125 psig) saturated steam.
      c. Turn down ratio, 20 to 1.
      d. Accuracy, plus or minus 1.0 percent of span.
      e. Repeatability, plus or minus 0.1 percent.
      f. Output signal, 4-20 ma DC.

g. Processor/Transmitter, NEMA 4 enclosure with keypad program selector and six digit LCD output display of instantaneous flow rate or totalized flow, solid state switch closure signal shall be provided to the nearest DDC panel for totalization.

   1) Ambient conditions, -20 to 50 degrees C (0-120 degrees F), 0 95 percent non-condensing RH.

   2) Power supply, 120 VAC, 60 hertz or 24 VDC.

   3) Internal battery, provided for 24-month retention of RAM contents when all other power sources are removed.

h. Sensor on all steam lines shall be protected by pigtail siphons installed between the sensor and the line, and shall have an isolation valve installed between the sensor and pressure source.

D. Flow switches:

1. Shall be either paddle or differential pressure type.

   a. Paddle-type switches (liquid service only) shall be UL Listed, SPDT snap-acting, adjustable sensitivity with NEMA 4 enclosure.

   b. Differential pressure type switches (air or water service) shall be UL listed, SPDT snap acting, NEMA 4 enclosure, with scale range and differential suitable for specified application.

E. Current Switches: Current operated switches shall be self powered, solid state with adjustable trip current as well as status, power, and relay command status LED indication. The switches shall be selected to match the current of the application and output requirements of the DDC systems.

2.5 ENGINEERING CONTROL CENTER (ECC)—OPERATOR'S WORKSTATION

A. Operator workstation(s) shall utilize standard Web Browser to connect to specific software and be able to access data from all the digital controllers distributed throughout the control systems. These workstations shall reside on the same high-speed network as the Network Area Controllers with the ability to remote dial or internet access to the system.

B. The ECC shall consist of the following:

1. Personal Computer: Microsoft compatible PC containing necessary software and hardware, including serial and parallel ports, network connections and all cables, and uninterruptible Power Source (UPS) system, necessary for the complete function of the control systems. The system shall be designed so that additional workstations and/or

peripheral equipment can be added in the future. The PC shall
contain the following as a minimum:

a. 750MHz Intel Pentium Processor.

b. 128MB RAM at 100 MHz.

c. 60GB Hard Drive.

d. One-die 256KB Cache.

e. 1.44MB Floppy, Disk Drive.

f. 48X CD-RW Drive.

g. 56 K Internal Modem.

h. Graphics: 32 MB Video memory.

i. Monitor: Capable of handling advanced graphics and multimedia
   applications.

j. Mouse/Keyboard: Quiet keyboard with 3-button mouse.

k. Uninterruptible power supply with minimum 30-minute backup.

2. Alarm Printer: Tractor-feed and 8-1/2x11 multi-fold type paper:

a. Speed: 160 characters per second.

b. Character spacing: Minimum 10 characters per inch.

c. Paper: One box of 2000 sheets of printer paper.

3. Laser Printer: Black and white:

a. Resolution: 1200x1200 dpi black text.

b. RAM: 4MB.

c. Speed: 10 pages per minute, with a 250-sheet paper cassette and
   with manual feed.

4. Monitor:

a. Size: 17-inch Flat Panel.

b. Resolution: 1280 X 1024.

c. Response Rate: 25 ms

d. Height adjustable and pivot rotation capability

5. Surge Protection: 110-volt strip with at least 6 outlet connections.

C. ECC Software:

1. The Controls Systems Operator Interfaces shall be user friendly,
   readily understood and shall make maximum use of colors, graphics,
   icons, embedded images, animation, text based information and data
   visualization techniques to enhance and simplify the use and
   understanding of the displays by authorized users at the ECC.

2. User access shall be protected by a flexible and Owner re-definable
   software-based password access protection. Password protection shall
   be multi-level and partitionable to accommodate the varied access

requirements of the different user groups to which individual users may be assigned. Provide the means to define unique access privileges for each individual authorized user. Provide the means to on-line manage password access control under the control of a project specific Master Password. Provide an audit trail of all user activity on the Controls Systems including all actions and changes.

    3. Operator Workstation shall be user friendly, easily understood and commercially available software, multi-tasking operating system. The operating system shall be Window NT or Windows 2000 XP or better, and shall support the third party software.

D. The system shall be completely field-programmable from the common operator's keyboard thus allowing hard disk storage of all data automatically. All programs for the CUs shall be able to be downloaded from the hard disk. The software shall provide the following functionality as a minimum:

    1. Point database editing, storage and downloading of controller databases.

    2. Scheduling and override of building environmental control systems.

    3. Collection and analysis of historical data.

    4. Alarm reporting, routing, messaging, and acknowledgement.

    5. Definition and construction of dynamic color graphic displays.

    6. Real-time graphical viewing and control of environment.

    7. Scheduling trend reports.

    8. Program editing.

    9. Operating activity log and system security.

    10. Transfer data to third party software.

E. Provide graphical user software, which shall minimize the use of keyboard through the use of the mouse and "point and click" approach to menu selection.

F. The software shall provide a multi-tasking type environment that will allow the user to run several applications simultaneously. The mouse or Alt-Tab keys shall be used to quickly select and switch between multiple applications. The operator shall be able automatically export data to and work in Microsoft Word, Excel, and other Windows based software programs, while concurrently on-line system alarms and monitoring information.

G. Provide functionality such that using the least amount of steps to initiate the desired event may perform any of the following simultaneously:

1. Dynamic color graphics and graphic control.

2. Alarm management.

3. Event scheduling.

4. Dynamic trend definition and presentation.

5. Program and database editing.

6. Each operator shall be required to log on to the system with a user name and password to view, edit or delete the data. System security shall be selectable for each operator, and the password shall be able to restrict the operator's access for viewing and changing the system programs. Each operator shall automatically be logged off the system if no keyboard or mouse activity is detected for a selected time.

H. Graphic Displays:

1. The workstation shall allow the operator to access various system schematics and floor plans via a graphical penetration scheme, menu selection, or text based commands. Graphic software shall permit the importing of AutoCAD or scanned pictures in the industry standard format (such as PCX, BMP, GIF, and JPEG) for use in the system.

2. Dynamic temperature values, humidity values, flow rates, and status indication shall be shown in their locations and shall automatically update to represent current conditions without operator intervention and without pre-defined screen refresh values.

3. Color shall be used to indicate status and change in status of the equipment. The state colors shall be user definable.

4. A clipart library of HVAC equipment, such as chillers, boilers, air handling units, fans, terminal units, pumps, coils, standard ductwork, piping, valves and laboratory symbols shall be provided in the system. The operator shall have the ability to add custom symbols to the clipart library.

5. A dynamic display of the site-specific architecture showing status of the controllers, PC workstations and network shall be provided.

6. The windowing environment of the workstation shall allow the user to simultaneously view several applications at a time to analyze total building operation or to allow the display of graphic associated with an alarm to be viewed without interrupting work in progress.

The graphic system software shall also have the capability to split screen, half portion of the screen with graphical representation and the other half with sequence of operation of the same HVAC system.

I. Trend reports shall be generated on demand or pre-defined schedule and directed to monitor display, printers or disk. As a minimum, the system shall allow the operator to easily obtain the following types of reports:

1. A general list of all selected points in the network.

2. List of all points in the alarm.

3. List of all points in the override status.

4. List of all disabled points.

5. List of all points currently locked out.

6. List of user accounts and password access levels.

7. List of weekly schedules.

8. List of holiday programming.

9. List of limits and dead bands.

10. Custom reports.

11. System diagnostic reports, including, list of digital controllers on the network.

12. List of programs.

J. Scheduling and Override:

1. Provide a calendar type format for time-of-day scheduling and overrides of building control systems. Schedules reside in the PC workstation, digital controllers shall ensure equipment time scheduling when PC is off-line. PC shall not be required to execute time scheduling. Provide override access through menu selection or function key. Provide the following spreadsheet graphics as a minimum:

a. Weekly schedules.

b. Zone schedules, minimum of 100 zones.

c. Scheduling up to 365 days in advance.

d. Scheduled reports to print at workstation.

K. Collection and Analysis of Historical Data:

1. Provide trending capabilities that will allow the operator to monitor and store records of system activity over an extended period of time. Points may be trended automatically on time based intervals or change of value, both of which shall be user definable. The trend interval could be five (5) minutes to 120 hours. Trend data may be

stored on hard disk for future diagnostic and reporting.
Additionally trend data may be archived to network drives or
removable disk media for off-site retrieval.

2. Reports may be customized to include individual points or predefined
groups of at least six points. Provide additional functionality to
allow pre-defined groups of up to 250 trended points to be easily
accessible by other industry standard word processing and
spreadsheet packages. The reports shall be time and date stamped and
shall contain a report title and the name of the facility.

3. System shall have the set up to generate spreadsheet reports to
track energy usage and cost based on weekly or monthly interval,
equipment run times, equipment efficiency, and/or building
environmental conditions.

4. Provide additional functionality that will allow the operator to
view real time trend data on trend graph displays. A minimum of 20
points may be graphed regardless of whether they have been
predefined for trending. In addition, the user may pause the graph
and take snapshots of the screens to be stored on the workstation
disk for future reference and trend analysis. Exact point values may
be viewed and the graph may be printed. Operator shall be able to
command points directly on the trend plot by double clicking on the
point.

L. Alarm Management:

1. Alarm routing shall allow the operator to send alarm notification to
selected printers or operator workstation based on time of day,
alarm severity, or point type.

2. Alarm notification shall be provided via two alarm icons, to
distinguish between routine, maintenance type alarms and critical
alarms. The critical alarms shall display on the screen at the time
of its occurrence, while others shall display by clicking on their
icon.

3. Alarm display shall list the alarms with highest priority at the top
of the display. The alarm display shall provide selector buttons for
display of the associated point graphic and message in English
language. The operator shall be able to sort out the alarms.

4. Alarm messages shall be customized for each point to display
detailed instructions to the operator regarding actions to take in
the event of an alarm.

     5. An operator with proper security level access may acknowledge and clear the alarm. All that have not been cleared shall be archived at workstation disk.

  M. Clock Synchronization:

     The system shall be able to automatically synchronize all system clocks from any operator-designated device in the system, and shall adjust for daylight savings and standard time, if applicable. In the event of a power failure, all clocks shall be adjusted on the command of an operator if the power outage is extended beyond 72 hours.

  N. Remote Communications:

     The system shall have the ability to dial out in the event of an alarm. Receivers shall include operator workstations, e-mail addresses, 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.

  O. System Configuration:

     1. Network control strategies shall not be restricted to a single digital controller, but shall be able to include data from all other network devices to allow the development of global control strategies.

     2. Provide automatic backup and restore of all digital controller databases on the workstation hard disk. In addition to all backup data, all databases shall be performed while the workstation is on-line without disturbing other system operations.

2.6 CONTROL CABLES

    As specified in Division 26.

2.7 THERMOSTATS AND HUMIDISTATS

  A. Room thermostats controlling heating and cooling devices shall have three modes of operation (heating - null or dead band - cooling). Wall mounted thermostats shall have manufacturer's recommendation finish, setpoint range and temperature display and external adjustment:

  1. Electronic Thermostats: Solid-state, microprocessor based, programmable to daily, weekend, and holiday schedules.

    a. Public Space Thermostat: Public space thermostat shall be a platinum sensor and shall not have a visible means of set point adjustment. Adjustment shall be via the digital controller to which it is connected.

       b. Patient Room Thermostats: Platinum sensor with set point adjustment and an indicator.

       c. Psychiatric Patient Room Sensors: Electronic duct sensor as noted under Article 2.4.

       d. Battery replacement without program loss.

B. Strap-on thermostats shall be enclosed in a dirt-and-moisture proof housing with fixed temperature switching point and single pole, double throw switch.

C. Freezestats shall have a minimum of 300 mm (one linear foot) of sensing element for each 0.093 square meter (one square foot) of coil area. A freezing condition at any increment of 300 mm (one foot) anywhere along the sensing element shall be sufficient to operate the thermostatic element.

2.8 FINAL CONTROL ELEMENTS AND OPERATORS

A. Fail Safe Operation: Control valves and dampers shall provide "fail safe" operation in either the normally open or normally closed position as required for freeze, moisture, and smoke or fire protection.

B. Spring Ranges: Range as required for system sequencing and to provide tight shut-off.

C. Power Operated Control Dampers (other than VAV Boxes): Factory fabricated, balanced type dampers. All modulating dampers shall be opposed blade type and gasketed. Blades for two-position, duct-mounted dampers shall be parallel, airfoil (streamlined) type for minimum noise generation and pressure drop.

    1. Leakage: Maximum leakage in closed position shall not exceed 7 L/S (15 CFMs) differential pressure for outside air and exhaust dampers and 200 L/S/ square meter (40 CFM/sq. ft.) at 50 mm (2 inches) differential pressure for other dampers.

    2. Frame shall be galvanized steel channel with seals as required to meet leakage criteria.

    3. Blades shall be galvanized steel or aluminum, 200 mm (8 inch) maximum width, with edges sealed as required.

    4. Bearing shall be nylon, bronze sleeve or ball type.

    5. Hardware shall be zinc-plated steel. Connected rods and linkage shall be non-slip. Working parts of joints shall be brass, bronze, nylon or stainless steel.

D. Operators shall be electric or pneumatic type operating at 140 kPa (20 psig) as required for proper operation.

1. See drawings for required control operation.

2. Metal parts shall be aluminum, mill finish galvanized steel, or zinc plated steel or stainless steel.

3. Maximum air velocity and pressure drop through free area the dampers:

   a. Smoke damper in air handling unit; 210 meter per minute (700 fpm).

   b. Duct mounted damper; 600 meter per minute (2000 fpm).

   c. Maximum static pressure loss, 50 Pascal (0.20 inches water gage).

E. Smoke Dampers and Combination Fire/Smoke Dampers: Dampers and operators are specified in Section 23 31 00, HVAC DUCTS AND CASINGS. Control of these dampers is specified under this Section.

F. Control Valves:

1. Valves shall be rated for a minimum of 150 percent of system operating pressure at the valve location but not less than 900 kPa (125 psig).

2. Valves 50 mm (2 inches) and smaller shall be bronze body with threaded or flare connections.

3. Valves 60 mm (2 1/2 inches) and larger shall be bronze or iron body with flanged connections.

4. Brass or bronze seats except for valves controlling media above 100 degrees C (210 degrees F), which shall have stainless steel seats.

5. Flow characteristics:

   a. Three way valves shall have a linear relation or equal percentage relation of flow versus value position.

   b. Two-way valves position versus flow relation shall be linear for steam and equal percentage for water flow control.

6. Maximum pressure drop:

   a. Two position steam control: 20 percent of inlet gauge pressure.

   b. Modulating Steam Control: 80 percent of inlet gauge pressure (acoustic velocity limitation).

   c. Modulating water flow control, greater of 3 meters (10 feet) of water or the pressure drop through the apparatus.

   d. Two position water valves shall be line size.

G. Damper and Valve Operators and Relays:

1. Pneumatic operators, spring return type with non-ferrous metal bellows or diaphragm of neoprene or other elastomer. Bellows or diaphragm shall be of sufficient size so that a change in operating

pressure of not more than two (2) percent of the total motor operating pressure range will be required to start the valve or damper moving. Provide positive positioning or sequencing relays with adjustable operating range and starting point for operators sequenced with other operators to permit adjustment of control sequences, except for control valves in confined spaces in terminal units, which may use springs with range selected to provide necessary sequencing.

2. Electric damper operator shall provide full modulating control of dampers. A linkage and pushrod shall be furnished for mounting the actuator on the damper frame internally in the duct or externally in the duct or externally on the duct wall, or shall be furnished with a direct-coupled design.

3. Electronic damper operators: VAV Box actuator shall be mounted on the damper axle or shall be of the air valve design, and shall provide complete modulating control of the damper. The motor shall have a closure torque of 35-inch pounds minimum with full torque applied at close off to attain minimum leakage.

PART 3 – EXECUTION

3.1   INSTALLATION

A. General:

1. Examine project plans for control devices and equipment locations; and report any discrepancies, conflicts, or omissions to COR for resolution before proceeding for installation.

2. Work Coordination: See GENERAL CONDITIONS.

3. Install equipment, piping, wiring /conduit parallel to or at right angles to building lines.

4. Install all equipment and piping in readily accessible locations. Do not run tubing and conduit concealed under insulation or inside ducts.

5. Mount control devices, tubing and conduit located on ducts and apparatus with external insulation on standoff support to avoid interference with insulation.

6. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.

7. Run tubing and wire connecting devices on or in control cabinets parallel with the sides of the cabinet neatly racked to permit tracing.

8. Install equipment level and plum.

B. Piping Installation:

1. Tubing passing through or buried in concrete shall be installed in rigid steel conduit of sufficient strength to prevent damage to tubing.

2. Except for short apparatus connections, non-metallic tubing in all exposed locations, including mechanical rooms shall be protected from damage by installing the tubing in electric conduit or raceways. Provide protective grommet where tubing exits conduit.

3. Non-metallic tubing exposed to outdoors shall be protected by a sleeve or larger tubing.

4. In concealed but accessible locations such as above lay-in ceilings, non-metallic tubing may be run without conduit or raceway.

5. All tubing which is not run in conduit or raceway, both metallic and non-metallic, shall be neatly routed and securely fastened to building structure at not more than 36-IN. intervals.

6. Welding shall be performed in accordance with Section 23 21 13, HYDRONIC PIPING and Section 23 22 13, STEAM AND CONDENSATE HEATING PIPING.

7. Label and identify control air piping in accordance with specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.

C. Electrical Wiring Installation:

1. Install conduits and wiring in accordance with Specification Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS.

2. Install signal and communication cables in accordance with Specification Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW).

3. Install conduit and wiring between operator workstation(s), digital controllers, electrical panels, indicating devices, instrumentation, miscellaneous alarm points, thermostats, and relays as shown on the drawings or as required under this section. All wiring shall be installed in conduits.

4. Install all electrical work required for a fully functional system and not shown on electrical plans or required by electrical specifications. Where low voltage power is required, provide suitable transformers.

     5. Install all system components in accordance with local Building Code and National Electric Code.

        a. Splices: Splices in shielded and coaxial cables shall consist of terminations and the use of shielded cable couplers. Terminations shall be in accessible locations. Cables shall be harnessed with cable ties.

        b. Equipment: Fit all equipment contained in cabinets or panels with service loops, each loop being at least 300 mm (12 inches) long. Equipment for fiber optics system shall be rack mounted, as applicable, in ventilated, self-supporting, code gauge steel enclosure. Cables shall be supported for minimum sag.

        c. Cable Runs: Keep cable runs as short as possible. Allow extra length for connecting to the terminal board. Do not bend flexible coaxial cables in a radius less than ten times the cable outside diameter.

        d. Use vinyl tape, sleeves, or grommets to protect cables from vibration at points where they pass around sharp corners, through walls, panel cabinets, etc.

     6. Conceal cables, except in mechanical rooms and areas where other conduits and piping are exposed.

     7. Permanently label or code each point of all field terminal strips to show the instrument or item served. Color-coded cable with cable diagrams may be used to accomplish cable identification.

     8. Grounding: ground electrical systems per manufacturer's written requirements for proper and safe operation.

  D. Install Sensors and Controls:

  1. Temperature Sensors:

     a. Install all sensors and instrumentation according to manufacturer's written instructions. Temperature sensor locations shall be readily accessible, permitting quick replacement and servicing of them without special skills and tools.

     b. Calibrate sensors to accuracy specified, if not factory calibrated.

     c. Use of sensors shall be limited to its duty, e.g., duct sensor shall not be used in lieu of room sensor.

     d. Install room sensors permanently supported on wall frame. They shall be mounted at 1.5 meter (5.0 feet) above the finished floor.

    e. Mount sensors rigidly and adequately for the environment within which the sensor operates.

    f. Sensors used in mixing plenum, and hot and cold decks shall be of the averaging of type. Averaging sensors shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip.

    g. All pipe mounted temperature sensors shall be installed in wells.

    h. All wires attached to sensors shall be air sealed in their conduits or in the wall to stop air transmitted from other areas affecting sensor reading.

    i. Permanently mark terminal blocks for identification. Protect all circuits to avoid interruption of service due to short-circuiting or other conditions. Line-protect all wiring that comes from external sources to the site from lightning and static electricity.

2. Pressure Sensors:

    a. Install duct static pressure sensor tips facing directly downstream of airflow.

    b. Install high-pressure side of the differential switch between the pump discharge and the check valve.

    c. Install snubbers and isolation valves on steam pressure sensing devices.

3. Actuators:

    a. Mount and link damper and valve actuators according to manufacturer's written instructions.

    b. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed position.

    c. Check operation of valve/actuator combination to confirm that actuator modulates valve smoothly in both open and closed position.

4. Flow Switches:

    a. Install flow switch according to manufacturer's written instructions.

    b. Mount flow switch a minimum of 5 pipe diameters up stream and 5 pipe diameters downstream or 600 mm (2 feet) whichever is greater, from fittings and other obstructions.

    c. Assure correct flow direction and alignment.

        d. Mount in horizontal piping-flow switch on top of the pipe.

  E. Installation of Network:

    1. Ethernet:

      a. The network shall employ Ethernet LAN architecture, as defined by IEEE 802.3. The Network Interface shall be fully Internet Protocol (IP) compliant allowing connection to currently installed IEEE 802.3, Compliant Ethernet Networks.

      b. The network shall directly support connectivity to a variety of cabling types. As a minimum provide the following connectivity: 10 Base 2 (ThinNet RG-58 A/U Coaxial cabling with BNC connectors), 10 Base T (Twisted-Pair RJ-45 terminated UTP cabling).

    2. Echelon:

      a. The ECC shall employ LonTalk communications FTT-10.

      b. Echelon LAN (Flat LON): The ECC shall employ a LON LAN that will connect through an Echelon Communication card directly to all controllers on the FTT-10 LAN.

    3. Third Party Interfaces: Contractor shall integrate real-time data from building systems by other trades and databases originating from other manufacturers as specified and required to make the system work as one system.

  F. Installation of Digital Controllers and Programming:

    1. Provide a separate digital control panel for each major piece of equipment, such as air handling unit, chiller, pumping unit etc. Points used for control loop reset such as outdoor air, outdoor humidity, or space temperature could be located on any of the remote control units.

    2. Provide sufficient internal memory for the specified control sequences and trend logging. There shall be a minimum of 25 percent of available memory free for future use.

    3. System point names shall be modular in design, permitting easy operator interface without the use of a written point index.

    4. Provide software programming for the applications intended for the systems specified, and adhere to the strategy algorithms provided.

    5. Provide graphics for each piece of equipment and floor plan in the building. This includes each chiller, cooling tower, air handling unit, fan, terminal unit, boiler, pumping unit etc. These graphics shall show all points dynamically as specified in the point list.

3.2   SYSTEM VALIDATION AND DEMONSTRATION

A. As part of final system acceptance, a System Demonstration is required (see below). Prior to start of this Demonstration, the contractor is to perform a complete Validation of all aspects of the Controls and Instrumentation System.

B. Validation

1. Prepare and submit for approval a Validation Test Plan including Test Procedures for the performance verification tests. Test Plan shall address all specified functions of the Engineering Control Center and all specified sequences of operation. Explain in detail actions and expected results used to demonstrate compliance with the requirements of this specification. Explain the method for simulating the necessary conditions of operation used to demonstrate performance of the system. Test Plan shall include a Test Check List to be used by the Installer's agent to check and initial that each test has been successfully completed. Deliver Test Plan documentation for the performance verification tests to the owner's representative 30 days prior to start of performance verification tests. Provide draft copy of operation and maintenance manual with performance verification test.

2. After approval of the Validation Test Plan, Installer shall carry out all tests and procedures therein. Installer shall completely check out, calibrate, and test all connected hardware and software to insure that system performs in accordance with approved specifications and sequences of operation submitted. Installer shall complete and submit Test Check List.

C. DEMONSTRATION

1. System operation and calibration to be demonstrated by the Installer in the presence of the Architect or Owner's representative on random samples of equipment as dictated by the Owner's representative. Should random sampling indicate improper commissioning, the owner reserves the right to subsequently witness complete calibration of the system at no addition cost to the owner.

2. Demonstrate to authorities that all required safeties and life safety functions are fully functional and complete.

3. Make accessible , personnel to provide necessary adjustments and corrections to systems as directed by balancing agency.

4. The following witnessed demonstrations of field control equipment shall be included:

   a. Pressure test control air piping at 1.25 times the design pressure. Pressure shall be applied in several stages, allowing time for the system to reach equilibrium. The test pressure shall not exceed the pneumatic test pressure for any pump, valve, or other component in the system under test. Pressure shall not drop more than 5% within 4 hours.

   b. Observe HVAC systems in shut down condition. Check dampers and valves for normal position.

   c. Test application software for its ability to communicate with digital controllers, operator workstation, and uploading and downloading of control programs.

   d. Demonstrate the software ability to edit the control program off-line.

   e. Demonstrate reporting of alarm conditions for each alarm and ensure that these alarms are received at the assigned location, including operator workstations.

   f. Demonstrate ability of software program to function for the intended applications-trend reports, change in status etc.

   g. Demonstrate via graphed trends to show the sequence of operation is executed in correct manner, and that the HVAC systems operate properly through the complete sequence of operation, e.g., seasonal change, occupied/unoccupied mode, and warm-up condition.

   h. Demonstrate hardware interlocks and safeties functions, and that the control systems perform the correct sequence of operation after power loss and resumption of power loss.

   i. Prepare and deliver to the VA graphed trends of all control loops to demonstrate that each control loop is stable and the set points are maintained.

   j. Demonstrate that each control loop responds to set point adjustment and stabilizes within one (1) minute. Control loop trend data shall be instantaneous and the time between data points shall not be greater than one (1) minute.

5. Witnessed validation demonstration of Operator's Terminal functions shall consist of:

   a. Running each specified report.

b. Display and demonstrate each data entry to show site specific
   customizing capability. Demonstrate parameter changes.

c. Step through penetration tree, display all graphics, demonstrate
   dynamic update, and direct access to graphics.

d. Execute digital and analog commands in graphic mode.

e. Demonstrate DDC loop precision and stability via trend logs of
   inputs and outputs (6 loops minimum).

f. Demonstrate EMS performance via trend logs and command trace.

g. Demonstrate scan, update, and alarm responsiveness.

h. Demonstrate spreadsheet/curve plot software, and its integration
   with database.

i. Demonstrate on-line user guide, and help function and mail
   facility.

j. Demonstrate digital system configuration graphics with
   interactive upline and downline load, and demonstrate specified
   diagnostics.

k. Demonstrate multitasking by showing dynamic curve plot, and
   graphic construction operating simultaneously via split screen.

l. Demonstrate class programming with point options of beep
   duration, beep rate, alarm archiving, and color banding.

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