State of Utah

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ADDENDUM #3

Date: April 12, 2007

To: Contractors

From: S'ean Crawford, Project Manager, DFCM

Reference: Science Building Remodel Phase 3
Utah Valley State College – Orem, Utah
DFCM Project No. 06317790

Subject: **Addendum No. 3**

Pages			
	Addendum	1	page
	Engineers Addendum & Specs.	16	pages
	Total	**17**	**pages**

Note: This Addendum shall be included as part of the Contract Documents. Items in this Addendum apply to all drawings and specification sections whether referenced or not involving the portion of the work added, deleted, modified, or otherwise addressed in the Addendum. Acknowledge receipt of this Addendum in the space provided on the Bid Form. Failure to do so may subject the Bidder to disqualification.

1.1 SCHEDULE CHANGES – There are no project schedule changes per this addendum.

1.2 GENERAL: Spectrum Engineers Addendum & Specifications.

End of Addendum #1

SPECTRUM
ENGINEERS

Addendum

Job: UVSC Science Building - Phase III
Job Number: 20070089
Date: April 11, 2007

MECHANICAL – DIV 15

DRAWINGS

SHEET - MH101
1. Add two return air grilles in room 109B (Herbarium).

SPECIFICATIONS

SECTION - 15971
1. Section has been revised. Refer to attached re-issued specification section.

PRIOR APPROVALS

Approval of equipment from catalog information indicated brand name and general characteristics are acceptable to the Engineer, but does not relieve the Contractor of the responsibility of providing equipment and accessories as specified unless specific mention of departments from specifications was made in the submittal and acknowledged in writing by the Engineer. Quantities and dimensions are not checked. We are retaining one set of submittal data for our files.

SECTION	ITEM	MANUFACTURER	COMMENT
15850	Exhaust Fans	CaptiveAire	approved

SECTION 15971 - AUTOMATIC TEMPERATURE CONTROLS.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the Building Management System (BMS) control equipment for HVAC systems and components.

1.3 DEFINITIONS

A. ARP: Address Resolution Protocol

B. ASD: Application Specific Device

C. BMS: Building Management System

D. CSMA/CD: Carrier Sense Multiple Access/Collision Detect

E. CIM: Control Interface Module

F. DDC: Direct Digital Control

G. GUI: Graphical User Interface

H. HVAC: Heating, Ventilation, and Air Conditioning

I. LAN: Local Area Network

J. MER: Mechanical Equipment Room

K. NIM: Network Interface Module

L. PID: Proportional, Integral, Derivative

1.4 SYSTEM DESCRIPTION

A. Furnish all labor, materials, equipment, and service necessary for a complete and operating temperature control system, utilizing a high speed peer to peer network of interoperable Direct Digital Controls (DDC), Graphical User Interface (GUI) with color graphic displays and electronic interfaces and actuation devices, as shown on the drawings and as described herein.

B. Complete temperature control system to be DDC with electronic sensors and electronic/electric actuation of Mechanical Equipment Room (MER) valves and dampers and electronic actuation of terminal equipment valves and actuators as

specified herein. The BMS is intended to seamlessly connect controllers throughout the building as well as seamlessly connect to the entire UVSC Campus DDC System.

C. All work described in this section shall be installed, wired, circuit tested and calibrated by Yamas Controls Intermountain, Inc. No subcontracting of the installation shall be allowed. Supervision, calibration and checkout of the system shall be by the regular employees of Yamas Controls Intermountain. The control contractor shall have an in place support facility within 40 miles of the site with factory certified technicians and engineers, spare parts inventory and all necessary test and diagnostic equipment for the installed system, and the control contractor shall have 24 hours/day, 7 days/week emergency service available. Services shall also be available for repair parts and related replacement components from Yamas Controls OTC.

D. All discarded electric control components including wiring is to be taken back to a logical place and left in a professional manner.

E. The intent of this project is to add automatic Temperature Controls (tac IA) to the newly installed VAV Boxes, Fan Coil Units, and Make Up Air Units as well as related exhaust fans. Prior to the installation of new components, Yamas Controls is to provide selective demolition to existing automatic temperature controls as required. Additionally, all newly installed temperature controls shall be seamlessly integrated into the existing campus wide tac-IA ATC system. No other controls manufacturers shall be considered.

1.5 INSTALLATION OF PRODUCTS FURNISHED AND INSTALLED UNDER THIS SECTION.

A. Section 15971 –Accessories:
   1. Temperature sensors
   2. All Direct Digital Controllers and associated control components (Cabinets, transformers, transmitters, transducers, relays/bases… etc)

1.6 SUBMITTALS.

A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
   1. Each control device labeled with setting or adjustable range of control.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Schematic flow diagrams showing Air Handling Units and newly installed control devices.
   2. Wiring Diagrams: Power, signal, and control wiring.
   3. Details of control panel faces, including controls, instruments, and labeling.
   4. Written description of sequence of operation.

5. Listing of connected data points, including connected control unit and input device.
6. System graphics indicating retrofitted air handling units

C. Samples: For each color required, of each type of thermostat cover.

D. Software and Firmware Operational Documentation: Include the following:.
1. Engineering, Installation, Operation and Maintenance manuals.
2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.
5. Licenses, guarantee, and warranty documents for all equipment and systems.

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

1.7 QUALITY ASSURANCE.

A. All work described in this section shall be installed, wired, circuit tested and calibrated by Yamas Controls factory certified technicians. Further, the ATC Contractor shall have their own factory certified installation professionals including electrical, mechanical and ATC Technicians.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.8 COORDINATION.

A. Coordinate location of thermostats, and other exposed control sensors with owner before installation.

1.9 WARRANTY AND MAINTENANCE.

A. All components, system software, and parts furnished and installed by Yamas Controls Intermountain, Inc shall be guaranteed against defects in materials and workmanship for 1 year of substantial completion. Damper actuators and control valves shall carry a standard 5-year factory warranty. Materials furnished but not installed by the BMS contractor shall be covered to the extent of the product only. Installation labor shall be the responsibility of the trade contractor performing the installation. All corrective software modifications made during warranty periods shall be updated on all user documentation and on user and manufacturer archived software disks. The Contractor shall respond to the owner's request for warranty service within 24 standard working hours.

1.10 OWNER RESPONSIBILITIES

A. Owner will verify that there is no asbestos existing in the work spaces prior to commencement of work. If asbestos is discovered during the project, the owner will be immediately notified and work stopped until proper certified remediation efforts can be made.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Manufacturers: All components and controllers shall be manufactured by the control contractor. Wording for this specification is based on the Invensys IA installed by Yamas Controls. Alternate proposals will not be entertained.
   1. Direct Digital Control Systems and Approved Installing Contractors:
      a. tac-IA installed by Yamas Controls Intermountain, Inc. (801-886-3300 Contact Bob Hooper) as an extension of the campus wide tac-IA DDC System
      b. No other Contractors will be considered.

2.2 GRAPHICAL USER INTERFACE

A. The color graphic terminal shall be driven by existing software which displays all information in a graphical format. The newly installed equipment shall meet or exceed all present campus graphics in both feature and functionality.

2.3 DDC EQUIPMENT

A. Universal Network Controllers (UNC)
   1. The Universal Network Controllers (UNC) shall provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the UNC. It shall be capable of executing application control programs to provide:
      a. Calendar functions
      b. Scheduling
      c. Trending
      d. Alarm monitoring and routing
      e. Time synchronization by means of an Atomic Clock Internet site including automatic synchronization
      f. Integration of LonWorks controller data and BACnet controller data
      g. Network Management functions for all LonWorks based devices
   2. The Universal Network Controller Type 1 must provide the following hardware features as a minimum:
      a. One Ethernet Port – 10/100 Mbps
      b. One RS-232 port
      c. One RS-232/RS485 port (ASD Communications port)

d. One LonWorks Interface Port – 78KB FTT-10A with Weidmuller connector
e. Power supply 24 VAC or 24 VDC
f. Battery Backup
g. Real-time clock
h. Processor @ 200 MHz or greater
i. Java Virtual Machine
j. 40 Mb flash memory for long term data backup (If battery backup or flash memory is not supplied, the controller must contain a hard disk with at least 1 gigabyte storage capacity)
k. 128 Mb Ram or greater

3. The UNC shall provide multiple user access to the system and support for ODBC or SQL. A database resident on the UNC shall be an ODBC compliant database or must provide an ODBC data access mechanism to read and write data stored within it.
4. The UNC shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 64 simultaneous users.
5. Event Alarm Notification and actions
   a. The UNC shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
   b. The UNC shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via dial-up telephone connection, or wide-area network.
   c. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but limited to:
      1) To alarm
      2) Return to normal
      3) To fault
   d. Provide for the creation of a minimum of eight of alarm classes for the purpose of routing types and or classes of alarms, i.e.: security, HVAC, Fire, etc.
   e. Provide timed (schedule) routing of alarms by class, object, group, or node.
   f. Provide alarm generation from binary object "runtime" and /or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.
   g. Control equipment and network failures shall be treated as alarms and annunciated.
   h. Alarms shall be annunciated in any of the following manners as defined by the user:
      1) Screen message text
      2) Email of the complete alarm message to multiple recipients. Provide the ability to route and email alarms based on:
         a) Day of week
         b) Time of day
         c) Recipient

3) Pagers via paging services that initiate a page on receipt of email message

4) Graphic with flashing alarm object(s)

5) Printed message, routed directly to a dedicated alarm printer

i. The following shall be recorded by the UNC for each alarm (at a minimum):

1) Time and date

2) Location (building, floor, zone, office number, etc.)

3) Equipment (air handler #, accessway, etc.)

4) Acknowledge time, date, and user who issued acknowledgement.

5) Number of occurrences since last acknowledgement.

j. Alarm actions may be initiated by user defined programmable objects created for that purpose.

k. Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.

l. A log of all alarms shall be maintained by the UNC and/or a server (if configured in the system) and shall be available for review by the user.

m. Provide a "query" feature to allow review of specific alarms by user defined parameters.

n. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.

o. An Error Log to record invalid property changes or commands shall be provided and available for review by the user.

6. Data Collection and Storage

a. The UNC shall have the ability to collect data for any property of any object and store this data for future use.

b. The data collection shall be performed by log objects, resident in the UNC that shall have, at a minimum, the following configurable properties:

1) Designating the log as interval or deviation.

2) For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.

3) For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.

4) For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis.

5) Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.

7. All log data shall be stored in a relational database in the UNC and the data shall be accessed from a server (if the system is so configured) or a standard Web Browser.

8. All log data, when accessed from a server, shall be capable of being manipulated using standard SQL statements.

9. All log data shall be available to the user in the following data formats:
   a. HTML
   b. XML
   c. Plain Text
   d. Comma or tab separated values
10. Systems that do not provide log data in HTML and XML formats at a minimum shall provide as an alternative Microsoft SQL Serverâ, Oracle 8i or Expressâ, Hyperion Solutions™ SQL Server.
11. The UNC shall have the ability to archive it's log data either locally (to itself), or remotely to a server or other UNC on the network. Provide the ability to configure the following archiving properties, at a minimum:
    a. Archive on time of day
    b. Archive on user-defined number of data stores in the log (buffer size)
    c. Archive when log has reached it's user-defined capacity of data stores
    d. Provide ability to clear logs once archived
12. AUDIT LOG
    a. Provide and maintain an Audit Log that tracks all activities performed on the UNC. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached it's user-defined buffer size. Provide the ability to archive the log locally (to the UNC), to another UNC on the network, or to a server. For each log entry, provide the following data:
       1) Time and date
       2) User ID
       3) Change or activity: i.e., Change setpoint, add or delete objects, commands, etc.
13. DATABASE BACKUP AND STORAGE
    a. The UNC shall have the ability to automatically backup its database. The database shall be backed up based on a user-defined time interval.
    b. Copies of the current database and, at the most recently saved database shall be stored in the UNC. The age of the most recently saved database is dependent on the user-defined database save interval.
    c. The UNC database shall be stored, at a minimum, in XML format to allow for user viewing and editing, if desired. Other formats are acceptable as well, as long as XML format is supported.

B. Custom Application Control Units:

Modular, comprising processor board with programmable, nonvolatile, RAM/EEPROM memory for custom control applications. CAC's shall be provided for Air Handling Units and shall have published Lon-Works™ application source code, device resource files and external interface definitions

1. Units monitor or control each input/output point; process information; and at least 50 expressions for customized HVAC control including mathematical equations, Boolean logic, PID control loops with anti-windup, sequencers, timers, interlocks, thermostats, enthalpy calculation, counters, interlocks, ramps, drivers, schedules, calendars, OSS, compare, limit, curve fit, and alarms.

2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
    a. Peer to peer primary network level communications supporting at least 200 LonMark™ Standard Network Variables (SNVTs) per CAC utilizing at least 100 different SNVT types as documented by the LonMark™ Interoperability Association to assure present and future compatibility with third party LonMark™ devices. The 200 LonMark™ SNVTs, minimum, must be configurable in any combination – all inputs or all outputs or any combination of input/outputs in any combination of the 100 different, minimum, SNVT types. The XIF SNVT order shall be definable, rather than random, to provide logical and effective LonMark™ network management. With the submittal package, contractor shall provide CAC performance data that specifies the exact maximum number of SNVTs available in any combination and a list of all available SNVT types including the LonMark™ Interoperability Association SNVT number.
    b. Automatic communications loss detection to maintain normal control functionality regardless of available network communications.
    c. Discrete/digital, analog, and pulse input/outputs.
    d. Monitoring, controlling, or addressing data points.
    e. Local energy management control strategies
    f. Incorporate internal customizable safeties and limits to prevent third party LonMark™ tools from providing improper and unrealistic inputs to CAC 's.
3. Local operator interface port provides for download from and connection to portable workstation.
4. Communication: The Custom Application Controller shall communicate via the Primary Controller Network between BMS Controllers and other LonWorks™ devices. CAC's shall communicate with the Building Controller and ASC's at a **baud rate of not less than 78.8K baud using LonTalk™** communications protocol (EIA 709.1).

C. Application Specific Control Units:

Single board construction comprising processor board with programmable, nonvolatile, RAM/EEPROM memory for custom control and unitary applications. ASCs shall be provided for Heat Pumps, Rooftop Energy Recovery Units, and other applications as shown on the drawings. To assure complete interoperability, all ASCs firmware shall support all mandatory and all optional LonMark™ Standard Network Variables (SNVTs) for their LonMark™ profile as documented by the LonMark™ Interoperability Association. Bidder shall provide proof of ASC compliance for all the mandatory and all optional LonMark™ SNVTs. ASCs shall be based on the Echelon Neuron 3150 microprocessor working with the ASCs stand alone control program.

1. Units monitor or control each input/output point; process information; and download from the operator station.
2. Stand-alone mode control functions operate regardless of network status. Functions include the following:

a. Peer to peer primary network level communications with automatic communications loss detection to maintain normal control functionality regardless of available network communications.
b. Discrete/digital, analog, and pulse input/output.
c. Monitoring, controlling, or addressing data points.
d. Appropriate LonMark™ profiles for specific unitary applications.
e. Support for all mandatory and optional LonMark™ Standard Network Variable Types (SNVTs) for their LonMark™ profile as documented by the LonMark™ Interoperability Association
f. Internal customizable safeties and limits to prevent third party LonMark™ tools from providing improper and unrealistic inputs to ASC's.

3. Local operator interface port located on ASC and ASC sensor provides for download from or upload to portable workstation. All Lon bus devices shall be accessible from either port.
4. Communication: ASC's shall communicate with the Building Controller and CAC's at a baud rate of not less than 78.8K baud using LonTalk™ communications protocol (EIA 709.1).
5. ASC units monitor or control each input/output point; process information; and at least 50 expressions for customized HVAC control including mathematical equations, Boolean logic, PID control loops with anti-windup, sequencers, timers, interlocks, thermostats, counters, interlocks, compare, limit, and alarms.
6. All ASC Controller setpoints shall be digital display setpoints with dual setpoint limits (integral hard limits which the user cannot exceed above and below and independent soft limits which are hidden from the user). All digital setpoints shall be network retentive after power outages and after replacement of sensor.

D. LANs:

Capacity for a minimum of 64 client workstations connected to multi-user, multitasking environment with concurrent capability to access DDC network or control units.

1. Enterprise Network LAN
   a. Media: Ethernet (IEEE 802.3), peer-to-peer CSMA/CD, operating at 10 or 100 Mbps, cable 10 Base-T, UTP-8 wire, category 5
2. Primary Controller Network LAN
   a. Media: LonTalk™ (EIA 709.1), peer to peer, FTT-10 operating at 78.8K.
3. Secondary Network LAN (If Required)
   a. Media: LonTalk™ (EIA 709.1), peer to peer, FTT-10 operating at 78.8K
4. Remote Connection
   a. ISDN, ADSL, T1 or dial-up connection, monthly charges paid by building owner

2.4 CONTROL PANELS

A. Local Control Panels: Unitized NEMA 1 cabinet with suitable brackets for wall or floor mounting, located adjacent to each system under automatic control. Provide common keying for all panels.

1. Fabricate panels of 0.06-inch thick, furniture-quality steel, or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock and with manufacturer's standard shop-painted finish.
2. Interconnections between internal and face-mounted devices pre-wired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL Listed for 600 volt service, individually identified per control/interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.
3. Door-Mounted Equipment: Flush-mount (on hinged door) manual switches, including damper-positioning switches, changeover switches, thermometers, and gages.
4. Provide ON/OFF power switch with over-current protection for control power sources to each local panel

2.5 SENSORS

A. Electronic Temperature Sensors: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required. Sensors to match the existing campus standards.
   1. Resistance Temperature Detectors: Platinum, thermistor, or balco
      a. Accuracy: Plus or minus 0.2 percent at calibration point; thermistors shall have a maximum 5 year drift of no more than .225°F maximum error of no more than .36°F
      b. Wire: Twisted, shielded-pair cable
      c. **Insertion Elements in Ducts:** Single point, 6 inches long; use where not affected by temperature stratification or where ducts are smaller than 4 sq. ft.
      d. **Averaging Elements in Ducts:** 60 inches, long, flexible for use where prone to temperature stratification or where ducts are larger than 4 sq. ft.; 264 inches long, flexible for use where prone to temperature stratification or where ducts are larger than 16 sq. ft; length as required.

B. Equipment operation sensors as follows:
   1. Status Inputs for Fans: Differential-pressure switch with adjustable range of 0 to 5 IN WC
   2. Status Inputs for Electric Motors: Current-sensing relay with current transformers, adjustable and set to 175 percent of rated motor current.

2.6 THERMOSTATS

A. Room Thermostat Cover
   1. Set-Point Adjustment: Concealed or exposed
   2. Set-Point Indication: Concealed or exposed
   3. Thermometer: Optional
   4. Color: Neutral
   5. Orientation: Vertical or horizontal

B. Room thermostat accessories include the following:
   1. Insulating Bases: For thermostats located on exterior walls.
   2. Thermostat Guards: As specified in tamper prone areas
   3. Adjusting Key: As required for calibration and cover screws.
   4. Set-Point Adjustment: 1/2-inch diameter, adjustment knob.

C. Electric Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic-reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below set point.
   1. Bulb Length: Minimum 20 feet
   2. Quantity: One thermostat for every 20 sq. ft. of coil surface.

D. Electric High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic-reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or above set point.
   1. Bulb Length: Minimum 20 feet.
   2. Quantity: One thermostat for every 20 sq. ft. of coil surface.

2.7 ACTUATORS

1. Electric Motors:

2.8 CONTROL CABLE

A. Electronic and Fiber-Optic Cable for Control Wiring: All communications cable shall be Cat 4 high speed wire. All wiring to match or exceed campus standard.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that conditioned power supply is available to control units and operator workstation.

B. Verify that duct, pipe, and equipment mounted devices and wiring are installed before proceeding with installation.

3.2 INSTALLATION

A. Install equipment level and plumb.

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

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

D. Verify location of thermostats and other exposed control sensors with plans and room details before installation. Locate all 60 inches above the floor.
   1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

E. Install hydronic instrument wells as required to house new immersion type temperature sensors.

3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Install raceways, boxes, and cabinets according to the LonMark interoperability society guidelines.

B. Install building wire and cable according to the LonMark interoperability society guidelines.
   1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
   2. Install exposed cable in raceway.
   3. Install concealed cable in raceway.
   4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
   5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
   6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.

3.4 CONNECTIONS

A. Ground equipment.
   1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: An Invensys certified service representative shall inspect field-assembled components and equipment installation and electrical connections. Report results in writing.
   1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove malfunctioning units, replace with new units, and retest.
   2. Test and adjust controls and safeties.
   3. Calibration and test electric/electronic thermostats by disconnecting input sensors and stimulating operation with compatible signal generator.

B. Replace damaged or malfunctioning controls and equipment.
   1. Start, test, and adjust control systems.

2. Demonstrate compliance with requirements, including calibration and testing, and control sequences.
3. Adjust, calibrate, and fine tune circuits and equipment to achieve sequence of operation specified.

C. Verify DDC as follows:
1. Verify software including automatic restart, control sequences, scheduling, reset controls, and occupied/unoccupied cycles.
2. Verify operation of operator workstation.
3. Verify local control units including self-diagnostics.

3.6 TRAINING

A. Provide a minimum of 16 hours of classroom training to be held during the contract period for personnel designated by the Owner. Train the designated staff of Owners Representative and Owner to enable them to:
1. Operate the system
2. Understand control system architecture and configuration
3. Understand DDC system components
4. Understand system operation, including DDC system control and optimizing routines (algorithms)
5. Operate the workstation and peripherals
6. Log on and off the system
7. Access graphics, point reports, and logs
8. Adjust and change system set points, time schedules, and holiday schedules
9. Recognize malfunctions of the system by observation of the printed copy and graphical visual signals
10. Understand system drawings, and Operation and Maintenance manual
11. Understand the job layout and location of control components
12. Access data from DDC controllers

SEQUENCE OF OPERATION

PART 4 - Execution

4.1 FMS SEQUENCE OF OPERATION

A. General Operation
Control Programs: The control programs to achieve the sequences of operation shall reside in the field controller. These controllers shall be capable of standalone operation, such that if communication with the network level controller is lost or disrupted, the sequence of operation will continue to operate. Global functions such as Scheduling, Optimal Start/Stop, and Outside Air Temperature Reset may reside on the Global Controller.

Optimal Start/Stop is incorporated into the energy management program. Any time a building experiences a system wide change of state (i.e. unoccupied-occupied or

power-up after loss of electrical power), the EMS shall initiate a system wide optimal start-up procedure so as to minimize the electrical demand based on a 15-minute sliding window.

Human Machine Interface (HMI): The HMI shall be a PC based graphical package. User's privileges determine whether setpoints and parameters can be modified or outputs manually overridden.

a. This graphical package shall contain graphical representations of the mechanical equipment.
b. The graphics shall display all the digital and analog points as listed in the points list for each mechanical system.
c. Digital output points shall have the capability to be manually overridden on and off from the HMI. These overrides may be timed, until or forever. Manual overrides cannot override any safety conditions.
d. Analog output points shall have the capability to be manually overridden on and off from the HMI. These overrides may be timed, until or forever. Manual overrides cannot override any safety conditions.
e. All setpoints, parameters and calculated values shall be displayed and adjustable from the HMI.
f. All setpoints and parameters defined as (adjustable) shall be adjustable from the HMI.

4.2 VAV BOXES

A. General

1. The ATC Contractor shall: 1) Furnish and field install the electronic VAV box DDC controllers, isolation transformers, damper actuators, velocity pressure sensors, discharge air temperature sensor 2) Furnish and install N2 communication from the NCM to the VAV box controller, 3) Furnish, mount and wire the room sensor, 4) Furnish and install centralized power transformer to provide 120vac/24vac power to the VAV box controller, 5) Furnish, install and wire a duct discharge air sensor at each VAV Box, 6) connect the room occupancy sensor to the VAV box controller for temperature setback.
2. The VAV box supplier shall furnish and install the flow pick-up sensors and a minimum 10 X 10 housing with cover.
3. The Electrical Contractor (Division 16000) shall provide, where shown on the electrical drawing, 120vac 20amp circuits above the ceiling space for power to the VAV box DDC controllers. Provide a minimum of one (1) junction box per six VAV boxes.
4. Occupied/Unoccupied mode of the zone shall be determined by the NCM, through the local controller and through the room occupancy sensor. The local DDC control loop shall modulate the primary damper to maintain the ventilation minimum CFM setpoint. On a fall in space temperature, the local control loop shall modulate the reheat coil to maintain setpoint temperature. On a further fall in space temperature the supply air volume will be reset between the ventilation minimum and the heating maximum setpoint. On a 100% call for heat, the VAV box shall control to the heating velocity setpoint and the control valve shall be wide open. The reverse shall occur on an increase in

space temperature equal to or greater than the heating temperature setpoint. When the space temperature is equal to or greater than the cooling temperature setpoint the VAV box processor shall enter the cooling mode. Using a PI^2 control loop, the control loop shall reset the box CFM setpoint from the minimum ventilation setpoint to the cooling maximum setpoint. In the unoccupied mode the VAV box damper shall be closed and the reheat coil valve closed. On a fall in space temperature below the unoccupied heating setpoint the control valves shall open and the primary air damper shall control to the heating volume to maintain the night set back setting.

5. The room occupancy sensor where shown on the electrical drawings shall setback the space temperature when the room is not occupied.
6. Provide a VAV box discharge air temperature sensor at each VAV box location.

4.3 FAN COIL UNITS

A. Furnish and install a local ASC controller for the fan coil units. When enabled by the OWS, the local ASC shall open the minimum outside air damper and modulate the hot water valve and/or chilled water valve and/or electric duct heater in sequence to maintain space temperature.

B. A current switch shall monitor fan status.

FIRE ALARM FAN SHUT-DOWN: (All Fan Systems)

All heating-ventilating-air conditioning system fans shall automatically shut off when the fire alarm system is energized. All fans to automatically start up again when fire alarm system is reset. Fan relays shall be "normally energized".

The ATC contractor shall provide interlock wiring from the control fire alarm panel to the DDC controller system.

END OF SECTION 15971