ADDENDUM TO THE CONTRACT

for the

MENDENHALL RIVER COMMUNITY SCHOOL
CONTROL UPGRADES, PHASE II
Contract No. BE-236

ADDENDUM NO.: **ONE**

CURRENT DEADLINE FOR BIDS:
May 30, 2018

PREVIOUS ADDENDA: **NONE**

ISSUED BY:

City and Borough of Juneau
ENGINEERING DEPARTMENT
155 South Seward Street
Juneau, Alaska 99801

DATE ADDENDUM ISSUED: **May 24, 2018**

The following items of the contract are modified as herein indicated. All other items remain the same. This addendum has been issued and is posted online. Please refer to the CBJ Engineering Contracts Division webpage at: http://www.juneau.org/engineering_ftp/contracts/Contracts.php

PROJECT MANUAL:

Item No. 1 SECTION 230932 – BUILDING AUTOMATION SYSTEM. ***Delete*** in its entirety, and ***replace*** with the attached SECTION 230932 – BUILDING AUTOMATION SYSTEM, labeled Addendum No. 1.

By: Greg Smith

Greg Smith,
Contract Administrator

Total number of pages contained within this Addendum: 28

SECTION 230923 - BUILDING AUTOMATION SYSTEM

PART 1 GENERAL

1.1 SUMMARY

A. This section specifies the requirements for the Building Automation System (BAS) to be installed in conjunction with this project.

B. Section includes
1. DDC controllers.
2. Air supply piping and tubing.
3. Control panel enclosures.
4. Humidistats.
5. Thermostats.
6. Control air dampers.
7. Electric damper actuators.
8. Control valves.
9. Electric valve actuators.
10. Thermostatic valve actuators.
11. Outside air measuring and modulation device.
12. Direct digital control system components.
13. Differential pressure monitor.

C. Not in Contract (future construction)
1. Control software.
2. PC workstation.

1.2 REFERENCES

A. American National Standards Institute:
1. ANSI MC85.1 - Terminology for Automatic Control.

B. Air Movement and Control Association International, Inc.:
1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.

C. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
1. ASHRAE 62 - Ventilation for Acceptable Indoor Air Quality.

D. American Society of Mechanical Engineers:
1. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
2. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

E. ASTM International:
1. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
2. ASTM A536 - Standard Specification for Ductile Iron Castings.
3. ASTM B32 - Standard Specification for Solder Metal.

4. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
5. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
6. ASTM D2737 - Standard Specification for Polyethylene (PE) Plastic Tubing.

F. American Welding Society:
1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.

G. National Electrical Manufacturers Association:
1. NEMA DC 3 - Residential Controls - Electrical Wall Mounted Room Thermostats.
2. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

H. National Fire Protection Association:
1. NFPA 72 - National Fire Alarm Code.
2. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.

I. Underwriters Laboratories, Inc.:

J. UL 1820 - Fire Test of Pneumatic Tubing for Flame and Smoke Characteristics.

1.3 DESCRIPTION OF WORK & SYSTEM DESCRIPTION

A. The systems shall be capable of integration into a Niagara based front-end software (not provided in contract, future construction).

B. The systems shall utilize BACnet as the protocol between main control panels, local graphical user interface, and Owner’s central graphical user interface.

C. The BAS contractor shall furnish and install a fully integrated building automation system, incorporating Direct Digital Control (DDC) and electric control for energy management, equipment monitoring and control, and subsystems as specified herein.

D. All materials and equipment used shall be standard components, regularly manufactured for this and/or other systems and not custom designed specifically for this project unless specifically noted otherwise. All systems and components shall have been thoroughly tested and proven in actual use for at least two years.

E. The BAS contractor shall be responsible for all BAS and temperature control wiring for a complete and operable system. All wiring shall be done in accordance with Division 26 of this specification and all local and national codes.

F. The BAS contractor shall furnish one Windows-based tablet or Windows-based laptop PC for local control and monitoring of the BAS system. The tablet or PC shall be equipped with the appropriate graphical software for control and monitoring of the system.

G. Provide control hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, and actuators.

H. Remote alarm messaging shall be provided to conditionally alert authorized persons of alarm conditions via text messaging. Alarm routing decisions shall be dependent on the type of alarm and schedules of Department's staff.

I. The BAS system shall be capable of remote monitoring via the owner's Ethernet network.

J. Automatic temperature controls field monitoring and control system using field programmable microprocessor based terminal equipment controllers with communications to Building Automation and Control System.

K. Base system on distributed system of fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment on token passing network, with central and remote hardware, software, and interconnecting wire and conduit.

L. Provide controls for variable air volume terminals, radiant ceiling panels, radiant floors, reheat coils, unit heaters, cabinet unit heaters, and fan coils when directly connected to control units. Individual terminal unit control is specified in Section 23 09 23.

M. Provide control systems consisting of thermostats, control valves, dampers and operators, indicating devices, interface equipment and other apparatus and accessories to operate mechanical systems, and to perform functions specified.

N. Provide installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience, and with service facilities within 1 travel day of Project.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience and minimum three previous projects working with Manufacturer.

1.5 SUBMITTALS

A. Section 01 30 00 – Administrative Requirements: Submittal procedures.

B. Shop Drawings: Indicate the following:
   1. System graphics showing monitored systems, data (connected and calculated) point addresses, and operator notations.
      a. Main Graphic Page
         1) Links to floorplans and specific equipment

2) General information to provide a 'building snapshot' coordinate with Owner's maintenance personnel for desired information
3) Navigation links
4) Legend

b. Floorplan graphics
1) Broken up by floor or wing as necessary
2) Color indication for high or low temperature rooms
3) Navigation links
4) Legend

c. Specific Equipment Graphics
1) Link to Sequence of Operation for specific equipment
2) Color indication for equipment status
3) Navigation links
4) Legend
5) Description of valve and damper open/closed status indication

2. Trunk cable schematic showing programmable control-unit locations and trunk data conductors.
3. Provide LAN or bus map of LAN or RS-485 bus between controllers accurately reflecting routing.
4. Connected data points, including connected control unit and input device.
5. System configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
6. Description and sequence of operation for operating, user, and application software.
7. Use terminology in submittals conforming to ASME MC85.1.
8. Coordinate submittals with information requested in Section 23 09 93.

C. Prior to ordering, installing or programming any portion of the system, submit the following in a tabbed and indexed package for review by the owner:
1. System Architecture diagram showing power supply, interconnection of system, Operator workstations, peripheral devices, and proposed location of controllers.
2. Equipment and components separated by individual subsystems.
3. Sequence of operations of individual subsystems and sequences for interaction of subsystems and the systems interaction with local and district wide controllers.
4. Valve and Damper Schedules.
5. Panel and Subpanel layout.
6. Orientation and Training Schedule and Course Outlines.

D. Product Data: Submit description and engineering data for each system component and software module. Include sizing as required.

E. Manufacturer's Installation Instructions: Submit installation instruction for each control system component.

F. Sequence of Operations: Sequence of Operation is to be evaluated by Contractor's Lead Technician and rewritten as necessary to describe exact programming to be provided. Exact reproduction of the control sequence from the construction documents does not sufficiently portray the Contractor's understanding of the expectations of this project and will be returned for resubmittal.

G. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

H. Contractor shall not proceed with any work until submittals are approved.

1.6 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.7 INSTALLATION SCHEDULING AND COORDINATION

A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.

B. The contractor is to schedule all work with other trades to ensure that the BAS installation is ready for substantial completion inspections and commissioning.

C. Coordinate installation of control components in piping systems with work of Section 23 21 16.

D. Coordinate installation of control components in duct systems with work of Section 23 33 00.

1.8 OPERATION AND MAINTENANCE MANUALS

A. All requirements of Section 23 01 00 for Operations and Maintenance Manuals are to be provided.

B. The O&M Manuals will contain as-built versions of all of the Submittal information. Updates are to include modifications made during startup and commissioning. The O&M Manuals are to include:
   1. Sequence of Operations
   2. Riser Diagrams
   3. Control Diagrams
   4. Panel layouts
   5. Valve Schedule
   6. Control Damper Actuator Schedule
   7. Product Data
   8. Point Summary Report
      a. Note which points/alarms are sent out to School District Facilities Management Department
   9. Commented Program Code
   10. Programming Block Diagrams
   11. Complete as-built wiring diagrams.
   12. List of software with current revision numbers.
   13. Trend Logs
   14. Maintenance information and parts list for all Building Automation components.
   15. PM schedule.

C. Submit hard copies and electronic copies as required by Section 23 01 00. One hard copy of the O&M Manual shall be located on site.

1.9 MAINTENANCE SERVICE

A. Section 01 70 10 - Execution and Closeout Requirements: Requirements for maintenance service.

B. Furnish service and maintenance of control systems for 1 year from Date of Substantial Completion.

C. Repair or replace parts in accordance with manufacturer's operating and maintenance data. Use parts produced by manufacturer of original equipment.

D. Perform work without removing units from service during building normal occupied hours.

E. Provide 24 hour emergency call back service for this maintenance period.

F. Maintain locally adequate stock of parts for replacement or emergency purposes. Have personnel available to ensure fulfillment of this maintenance service, without unreasonable loss of time.

G. Perform maintenance work using competent and qualified personnel under supervision and in direct employ of manufacturer or original installer.

H. Do not assign or transfer maintenance service to agent or subcontractor without prior written consent of Owner.

PART 2 PRODUCTS

2.1 DIRECT DIGITAL CONTROLS

A. Approved manufacturers:

1. Automated Logic as provided by Meridian Systems Inc.
401 W International Airport Rd, Suite 13, Anchorage, AK 99518

2. Distech or LONG Building Automation as provided by LONG Building Technologies, Inc.
5660 B St, Anchorage, Alaska 99518

3. Delta Controls as provided by Alaska Integrated Services
383 Industrial Way Ste. 100, Anchorage, Alaska 99501

4. Siemens Industry, Inc.
5333 Fairbanks St., Ste. B, Anchorage, AK 99518

2.2 OPERATING SYSTEM SOFTWARE (not in contract, future construction)

A. The systems shall be capable of integration into a Niagara based front-end software (not provided in contract, future construction).

B. See: Stand-alone DDC Controllers.

2.3 ENERGY MANAGEMENT AND LOAD CONTROL PROGRAMS

A. General: Support inch-pounds and S.I. metric units of measurement.

B. Demand Limiting:
1. Monitor total power consumption for each power meter and shed associated loads automatically to reduce power consumption to an operator set maximum demand level.
2. Input: Pulse count from incoming power meter connected to pulse accumulator in control unit.
3. Forecast demand (kW): Predicted by sliding window method.
4. Automatically shed loads throughout the demand interval selecting loads with independently adjustable on and off time of between one and 255 minutes.
5. Demand Target: Minimum of 3 for each demand meter; change targets based upon (1) time, (2) status of pre-selected points, or (3) temperature.
6. Load: Assign load shed priority, minimum "ON" time and maximum "OFF" time.
7. Limits: Include control band (upper and lower limits).
8. Output advisory when loads are not available to satisfy required shed quantity, advise shed requirements and require operator acknowledgment.

C. Duty Cycling:
1. Periodically stop and start loads, based on space temperature, and according to various On/Off patterns.
2. Modify off portion of cycle based on operator specified comfort parameters. Maintain total cycle time by increasing on portion of cycle by equal quantity off portion is reduced.
3. Set and modify following parameters for each individual load.
   a. Minimum and maximum off time.
   b. On/Off time in one-minute increments.
   c. Time period from beginning of interval until cycling of load.
   d. Manually override the DDC program and place a load in an On or Off state.
   e. Cooling Target Temperature and Differential.
   f. Heating Target Temperature and Differential.
   g. Cycle off adjustment.

D. Automatic Time Scheduling: Provide pre-programmed schedules for simple and intuitive on/off control.
1. Self-contained programs for automatic start/stop/scheduling of building loads.
2. Support up to seven (7) normal day schedules, seven (7) "special day" schedules and two (2) temporary day schedules.

3. Special day's schedule supporting up to 30 unique date/duration combinations.
4. Number of loads assigned to time program; with each load having individual time program.
5. Each load assigned at least 16 control actions for each day with 1 minute resolution.
6. Furnish the following time schedule operations:
   a. Start.
   b. Optimized Start.
   c. Stop.
   d. Optimized Stop.
   e. Cycle.
   f. Optimized Cycle.
7. Capable of specifying minimum of 30 holiday periods up to 100 days in length for the year.
8. Create temporary schedules.
9. Broadcast temporary "special day" date and duration.

E. Start/Stop Time Optimization:
1. Perform optimized start/stop as function of outside conditions, inside conditions, or both.
2. Adaptive and self-tuning, adjusting to changing conditions unattended.
3. For each point under control, establish and modify:
   a. Occupancy period.
   b. Desired temperature at beginning of occupancy period.
   c. Desired temperature at end of occupancy period.

F. Night Setback/Setup Program: Reduce heating space temperature set point or raise cooling space temperature set-point during unoccupied hours; in conjunction with scheduled start/stop and optimum start/stop programs.

G. Calculated Points: Define calculations and totals computed from monitored points (analog/digital points), constants, or other calculated points.
1. Employ arithmetic, algebraic, Boolean, and special function operations.
2. Treat calculated values like any other analog value; use for any function where a "hard wired point" might be used.

H. Event Initiated Programming: Any data point capable of initiating event, causing series of controls in a sequence.
1. Define time interval between each control action between 0 to 3600 seconds.
2. Output may be analog value.
3. Provide for "skip" logic.
4. Verify completion of one action before proceeding to next action. When not verified, program capable of skipping to next action.

I. Direct Digital Control: Furnish with each control unit Direct Digital Control software so operator is capable of customizing control strategies and sequences of operation by defining appropriate control loop algorithms and choosing optimum loop parameters.
1. Control loops: Defined using "modules" are analogous to standard control devices.

2. Output: Paired or individual digital outputs for pulse width modulation, and analog outputs.
3. Firmware:
   a. PID with analog or pulse-width modulation output.
   b. Floating control with pulse-width modulated outputs.
   c. Two-position control.
   d. Primary and secondary reset schedule selector.
   e. Hi/Low signal selector.
   f. Single pole double-throw relay.
   g. Single pole double throw time delay relay with delay before break, delay before make and interval time capabilities.
4. Direct Digital Control loop: Downloaded upon creation or on operator request. On sensor failure, program executes user defined failsafe output.
5. Display: Value or state of each of lines interconnecting DDC modules.

J. Fine Tuning Direct Digital Control PID or floating loops:
1. Display information:
   a. Control loop being tuned.
   b. Input (process) variable.
   c. Output (control) variable.
   d. Set-point of loop.
   e. Proportional band.
   f. Integral (reset) Interval.
   g. Derivative (rate) Interval.
2. Display format: Graphic, with automatic scaling; with input and output variable superimposed on graph of "time" versus "variable".

K. Trend logging:
1. Each control unit capable of storing samples of control unit's data points.
2. Update file continuously at operator assigned intervals.
3. Automatically initiate upload requests and then stores data on hard disk.
4. Time synchronize sampling at operator specified times and intervals with sample resolution of one minute.
5. Co-ordinate sampling with specified on/off point- state.
6. Display trend samples on workstation in graphic format. Automatically scale trend graph with minimum 60 samples of data in plot of time versus data.

2.4 HVAC CONTROL PROGRAMS

A. General:
1. Support Inch-pounds and S.I. metric units of measurement.
2. Identify each HVAC Control system.

B. Optimal Run Time:
1. Control start-up and shutdown times of HVAC equipment for both heating and cooling.
2. Base on occupancy schedules, outside air temperature, seasonal requirements, and interior room mass temperature.

3. Start-up systems by using outside air temperature, room mass temperatures, and adaptive model prediction for how long building takes to warm up or cool down under different conditions.
4. Use outside air temperature to determine early shut down with ventilation override.
5. Analyze multiple building mass sensors to determine seasonal mode and worse case condition for each day.

C. Supply Air Reset:
1. Monitor heating and cooling loads in building spaces, terminal reheat systems, both hot deck and cold deck temperatures on dual duct and multizone systems, single zone unit discharge temperatures.
2. Adjust discharge temperatures to most energy efficient levels satisfying measured load by:
   a. Raising cooling temperatures to highest possible value.
   b. Reducing heating temperatures to lowest possible level.

D. Enthalpy Switchover:
1. Calculate outside and return air enthalpy using measured temperature and relative humidity; determine energy expended and control outside and return air dampers.

2.5 PROGRAMMING APPLICATION FEATURES

A. Trend Point:
1. Sample points, real or computed, with each DDC Controller capable of collecting 250 samples at intervals specified in minutes, hours, days, or month.
2. Output trend logs as line-graphs or bar graphs. Output graphic on terminal, with each point for line and bar graphs designated with a unique pattern or color, vertical scale either actual values or percent of range, and horizontal scale time base. Print trend logs up to 12 columns of one point/column.

B. Alarm Messages:
1. Allow definition of minimum of 256 messages, each having minimum length of 60 characters for each individual message.
2. Assign alarm messages to system messages including point's alarm condition, point's off-normal condition, totaled point's warning limit, hardware elements advisories.
3. Output assigned alarm with "message requiring acknowledgment".
4. Operator commands include define, modify, or delete; output summary listing current alarms and assignments; output summary defining assigned points.

C. Weekly Scheduling:
1. Automatically initiate equipment or system commands, based on selected time schedule for points specified.
2. Program times for each day of week, for each point, with one minute resolution.
3. Automatically generate alarm output for points not responding to command.
4. Allow for holidays, minimum of 366 consecutive holidays.
5. Operator commands:
   a. System logs and summaries.

b. Start of stop point.
c. Lock or unlock control or alarm input.
d. Add, delete, or modify analog limits and differentials.
e. Adjust point operation position.
f. Change point operational mode.
g. Open or close point.
h. Enable/disable, lock/unlock, or execute interlock sequence or computation profile.
i. Begin or end point totals.
j. Modify total values and limits.
k. Access or secure point.
l. Begin or end HVAC or load control system.
m. Modify load parameter.
n. Modify demand limiting and duty cycle targets.

6. Output summary: Listing of programmed function points, associated program times, and respective day of week programmed points by software groups or time of day.

D. Interlocking:
1. Permit events to occur, based on changing condition of one or more associated master points.
2. Binary contact, high/low limit of analog point or computed point capable of being used as master. Master capable of monitoring or commanding multiple slaves.
3. Operator commands:
a. Define single master/multiple master interlock process.
b. Define logic interlock process.
c. Lock/unlock program.
d. Enable/disable interlock process.
e. Execute terminate interlock process.
f. Request interlock type summary.

2.6 DDC NETWORKING COMMUNICATIONS

A. The design of the BAS shall network stand-alone DDC Controllers. The network architecture shall consist of three levels; an Ethernet Management Level Network (MLN) based on TCP/IP protocol, an Ethernet Peer-to-Peer Building Level Network (BLN) between DDC controllers based on TCP/IP protocol, and a high-performance Terminal Equipment Controller (TEC) floor level local area networks (FLN). Access to the system shall be totally transparent to the user when accessing data or developing control programs.

B. The design of the BAS shall allow the co-existence of new DDC Controllers with existing DDC Controllers on the same network without the use of gateways, protocol converters, or third-party interface devices.

C. Management Level Network
1. All operator workstation PCs shall simultaneously direct connect to the Ethernet and Management Level Network without the use of an interposing device.

2. The Management Level Network shall not impose a maximum constraint on the number of operator workstations.
3. Simultaneous user access to network limited to number of site licenses issued to user.
4. When appropriate, any DDC controller residing on the peer-to-peer building level network shall connect to Ethernet network without the use of a PC.
5. Any PC on the Ethernet Management Level Network shall have transparent communication with controllers on the building level networks connected via Ethernet as well as directly connected building level networks. Any PC shall be able to interrogate any controller on the building level network in addition to being able to download program changes to individual controllers.
6. The Management Level Network shall reside on industry standard Ethernet utilizing standard TCP/IP, IEEE 802.3.
7. Access to the system database shall be available from any client workstation on the Management Level Network.

D. Peer-to-Peer Building Level Network (BLN)
1. The system shall have the ability to support integration of third party systems (fire alarm, security, lighting, Variable Frequency Drives, PLCs, chillers, boilers) via a panel mounted open protocol processor. This processor shall exchange data between the two systems for inter-process control. All exchange points shall have full system functionality as specified herein.
2. Data transfer via RS485.

E. High-Performance Floor Level Network (FLN)
1. This level communication shall support a family of application specific controllers and shall communicate with the peer-to-peer network through DDC Controllers for transmission of global data.

F. Break in Communication Path: Alarm and automatically initiate LAN reconfiguration.

2.7 PORTABLE OPERATOR WORKSTATION

A. No operators workstation, laptop, or tablet PC required for Phase II.

B. See: Stand-alone DDC Controllers.

2.8 STAND-ALONE DDC CONTROLLERS

A. Units: Modular in design and consisting of processor board with programmable RAM memory, local operator access and display panel, and integral interface equipment.

B. Battery Backup: Minimum of 1 hour UPS backup for DDC Controllers for protection against brown-outs or power loss.

C. Control Units Functions:
1. Hosting of web-based graphics.
2. Trend log collection and reporting.
3. Alarm Reporting.

4. Auto Database backup after a power failure.
5. Monitor or control each input/output point.
6. Completely independent with hardware clock/calendar and software to maintain control independently.
7. Sufficient memory to support its own operating system and databases.
8. Acquire, process, and transfer information to operator station or other control units on network.
9. Accept, process, and execute commands from other control unit's or devices or operator stations.
10. Access both data base and control functions simultaneously.
11. Record, evaluate, and report changes of state or value occurring among associated points. Continue to perform associated control functions regardless of status of network.
12. Perform in stand-alone mode:
    a. Start/stop.
    b. Duty cycling.
    c. Automatic Temperature Control.
    d. Demand control via a sliding window, predictive algorithm.
    e. Event initiated control.
    f. Calculated point.
    g. Scanning and alarm processing.
    h. Full direct digital control.
    i. Trend logging.
    j. Global communications.
    k. Maintenance scheduling.

D. Global Communications:
1. Broadcast point data onto network, making information available to other system controls units.
2. Transmit input/output points onto network for use by other control units and use data from other control units.

E. Input/output Capability:
1. Discrete/digital input (contact status).
2. Discrete/digital output.
3. Analog input.
4. Analog output.
5. Pulse input (5 pulses/second).
6. Pulse output (0-655 seconds in duration with 0.01-second resolution).

F. Monitor, control, or address data points. Include analog inputs, analog outputs, pulse inputs, pulse outputs and discrete inputs/outputs. Furnish control units with minimum 10 percent spare capacity.

G. Point Scanning: Set scan or execution speed of each point to operator selected time from 1 to 250 seconds.

H. Upload/Download Capability: Download from or upload to operator station. Upload/Download time for entire control unit database maximum 10 seconds on hard-wired LAN or 60 seconds over voice grade phone lines.

I. Test Mode Operation: Place input/output points in test mode to allow testing and developing of control algorithms on line without disrupting field hardware and controlled environment. In test mode:
1. Inhibit scanning and calculation of input points. Issue manual control to input points (set analog or digital input point to operator determined test value) from workstation.
2. Control output points but change only database state or value; leave external field hardware unchanged.
3. Enable control-actions on output points but change only data base state or value.

J. Local display and adjustment panel: Portable or Integral to control-unit containing digital display, and numerical keyboard. Display and adjust:
1. Input/output point information and status.
2. Controller set points.
3. Controller tuning constants.
4. Program execution times.
5. High and low limit values.
6. Limit differential.
7. Set/display date and time.
8. Control outputs connected to the network.
9. Automatic control outputs.
10. Perform control unit diagnostic testing.
11. Points in "Test" mode.

2.9 TERMINAL EQUIPMENT CONTROLLERS

A. Control of terminal units such as VAV boxes, fan-coil units and reheat coils shall be accomplished by a microprocessor based stand-alone controller utilizing direct digital control. The Terminal Equipment Controller (TEC) shall interface to the building control system in a multi-drop communications network originating at the DDC field panel. An individual controller shall be provided for each terminal unit. The terminal controller must be listed by Underwriters Laboratory under UL 916 PAZX and UL 864 UDTZ.

B. TEC valve and damper actuators shall be of the 24 VAC floating point type. Upon power loss, the actuator will maintain its current damper position. Position status is shown in percentage open notation.

C. TEC room temperature sensors shall come complete with a terminal jack. The terminal jack shall be used to connect a portable operator’s terminal to control and monitor all hardware and software points associated with the terminal unit.

2.10 AIR SUPPLY PIPING AND TUBING

A. Virgin Polyethylene Non-metallic Tubing: ASTM D2737, with flame-retardant harness for multiple tubing.
   1. Fittings: Polyethylene.
   2. Joints: Compression or push-on type

2.11 CONTROL PANEL ENCLOSURES

A. Furnish for each system under automatic control with relays and controls mounted in cabinet.

B. Construction: NEMA 250, Type 1, steel enclosure.

C. Covers: Detachable hinge, held closed by flush latch operable by key.

D. Enclosure Finish: Manufacturer's standard enamel.

2.12 CONTROL VALVES

A. Manufacturers:
   1. Siemens.
   2. Johnson.
   3. Belimo.
   4. Or pre-approved equal.

B. Unless otherwise noted in the sequence of operation, heating valves shall fail in the position that provides heat to the space.
   1. The exception to this requirement is that radiant floor systems are to fail closed in order to protect the slab.
   2. Terminal unit reheat coil valves may fail in place.

C. Valve normal position field changeable from N.O. to N.C. by replacement of the actuator or replacement of stem and valve cage for all valves except radiation valves.

D. All automatic control valves shall be full proportioning type with modulating plugs or for control ball valves with disk that provided equal percentage characteristics. Two-Way valves must be equal percentage flow characteristic. Three-Way valves may be equal percentage or linear flow characteristic. Size the valves for the maximum pressure drop of three to four psi at design flow and provide with actuators of sufficient power for the duty intended. Valve body and actuator to handle system pressure and close against the differential pressures encountered on the project. Valve features as follows: Stainless steel stems and spring loaded teflon or synthetic rubber U-Cup packing; or control ball valve with fiberglass reinforced Teflon seats, packing is two O-rings, trim is stainless steel for modulation or chrome plated brass for on/off; body rating in accordance with ANSI specification B 16; flow direction arrows permanently fixed to body.

E. Globe Pattern:

1. 2 inches and Smaller: Bronze body, bronze trim, rising stem, renewable composition disc, screwed ends.
2. 2-1/2 inches and Larger: Iron body, bronze trim, rising stem, plug-type disc, flanged ends, renewable seat and disc.
3. Hydronic Systems:
   a. Rate for service pressure of 125 psig at 250 degrees F.
   b. Replaceable plugs and seats of stainless steel or brass.
   c. Sizing: Size for 3 psig maximum pressure drop at design flow rate.
   d. Furnish two-way valves with equal percentage characteristics. Furnish three way valves with linear characteristics. Size two way valve actuators to close valves against pump shut off head.
4. Steam Systems:
   a. Rate for service pressure of 125 psig at 250 degrees F.
   b. Replaceable plugs and seats of stainless steel.
   c. Sizing: 10 psig inlet pressure and 5 psig pressure drop.
   d. Furnish valves with modified linear characteristics.

F. Ball Valves:
1. Threaded ends for 2-way valves 3 inches and smaller. Threaded ends for 3-way valves 2 inches and smaller.
2. Forged brass body, chrome plated brass ball and blowout proof stem and EPDM O-rings with minimum 600 psig rating.
3. Fluid Temperature Range: minus 20 to 250 degrees F.
4. Sizing: 3 psig maximum pressure drop at design flow rate.
5. Flow Characteristics: Furnish 2-way valves with equal percentage characteristics. Furnish 3-way valves with equal percentage characteristic through control port and linear characteristic through bypass port.
6. Size 2-way valve actuators to close valves against pump shut off head.

G. Butterfly Valves:
1. Service Pressure Rating: 125 psig at 250 degrees F.
2. Construction: ASTM A126 cast-iron or ASTM A536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals.
3. Body Style: Wafer, or Lug.
4. Disc: Bronze or Stainless steel.
5. Resilient replaceable seat for service to 250 degrees F.
   a. Size for 1 psig maximum pressure drop at design flow rate.

H. Terminal Unit Control Valves:
1. Brass body, Class 250, nickel plated brass ball, with optimizer insert for modulating applications, blow out resistant stem, threaded ends.
2. Two or three way as indicated in schedule or on Drawings.
3. Integral actuator.
4. Spring return required for unit ventilator heating valves and other terminal equipment with outside air.
5. Furnish non-spring return valves with manual override capability built into actuator.

6. Minimum Fluid Temperature: 20 degrees F.
7. Maximum Operating Conditions: 250 degrees F.
8. Sizing: 3 psig maximum pressure drop at design flow rate, to close against pump shutoff head.
9. Flow Characteristics: Furnish two-way and three-way valves with equal percentage characteristics.

2.13 CONTROL DAMPERS (see 23 33 00 Air Duct Accessories)

2.14 ELECTRIC ACTUATORS FOR CONTROL VALVES AND CONTROL DAMPERS

A. Manufacturers:
1. Siemens.
2. Johnson.
3. Belimo.
4. Or approved equal.

B. Unless otherwise noted in the sequence of operation, heating valves shall fail in the position that provides heat to the space and control damper actuators are to fail in a position that protects the space from freezing.
1. The exception to this requirement is that radiant floor systems are to fail closed in order to protect the slab.

C. Damper actuators shall be rotary action-type (90 degree) designed for direct connection to damper shaft wherever possible. Provide position indication on exterior of actuator body. Provide all actuators with manual override function.

D. Actuators shall function properly within the range of 85 to 110 percent of line voltage.

E. Operation: Two-position, Reversing type proportional motor. Specific applications may require 0-10 V Spring-return.

F. Enclosure Rating: NEMA 250 Type 1.

G. Mounting: Direct mount.

H. Stroke: 90 seconds end to end full stroke, 15 seconds return to normal for spring return.

I. Protection: Electronic stall protection.

J. Control Input: 0-10 VDC or 4-20 mA DC.

K. Power: Nominal 24 volt AC or 120 volt AC for line-voltage on/off systems.

L. Torque: Size for minimum 150 percent of required duty.

M. Duty cycle: rated for 65,000 cycles.

N. Accessories:

1. Cover mounted transformer.
2. Auxiliary potentiometer.
3. Damper linkage.
4. Direct drive feedback potentiometer.
5. Output position feedback.
6. Field selectable rotational, spring return direction, field adjustable zero and span.
7. End switch.

O. Actuators indicated by Normally Closed or Normally Open designation on drawings or in sequence of operation shall be spring return type.

P. Indicate on submittal literature the operation force capability of each model of damper motor in inch pounds of torque. Size motors so that a minimum of six inch pounds of force is available for each square foot of standard damper, eight inch pounds of force for each square foot of low leakage damper, or 150 percent of the published torque requirements of the damper, whichever is greater.

Q. Floating point actuators shall complete calibration cycles between the hours of 2 am and 6 am. Cycles shall be offset to keep from adversely affecting the operation of the system. This time shall be adjustable by the District.

2.15 BUILDING PRESSURE MONITORING

A. Manufacturers:
1. Ebtron Bleed Airflow Sensor EB-Flow
2. Or pre-approved equal.

B. Factory assembled bleed airflow monitor and accessories.

C. Building pressure measurement by sensing airflow rate induced by pressure measurement.

D. Construction:
1.
2. Stationary Sensing:
   a. Style: Thermal-dispersion sensing elements.
   b. Orientation: Horizontal.
   c. Material: Heavy gage aluminum.
   d. Finish: Anodized.
3. Digital Controller: Application specific controller. Programming logic and calibration in nonvolatile EPROM. Controller uses generic 0 - 10 vdc or 4-20 mA inputs and outputs for interface to building automation system.
4. Finish: Mill aluminum.

E. Performance Data:
1. Temperature Rating: Withstand -20 to 120 degrees F.
2. Range: -2000 to 2000 fpm
3. Accuracy: Plus or minus 5 percent.
4. Provides 2 to 10 volt DC signal corresponding to actual air flow.

5. Provides pressure alarming.

2.16 DDC SENSORS & SWITCHES

A. Temperature Sensors:
1. Type: Resistance temperature detector (RTD) or thermistor.
2. Accuracy:
a. Plus or minus 1 degree F for standard applications. Where high accuracy is required, furnish accuracy of plus or minus 0.2 degrees F.
b. Sensing Accuracy: Plus or minus 0.5 degree F.
c. Display Accuracy and Resolution: Minimum of plus or minus 1 degree F.
d.
3. Built-in communications port.
4. Space Sensors: Digital with LCD display, day-night override button, and set point slide adjustment override options. Set point slide adjustment capable of being software limited by automation system to limit amount of room adjustment.
5. Outside Air Sensors: Watertight inlet fitting, furnish with shield from direct sunlight.
6. Duct Temperature Sensors:
a. Rigid or averaging type as indicated in sequence of operations. Averaging sensor minimum length: 5 feet in length.
b. Duct Cross Sections Greater Than 10 square feet: Furnish serpentine averaging element to sense stratified air temperatures.
c.
7. Piping Temperature Sensors: Furnish with separable brass well.

B. Humidity Sensors:
1. Type: Capacitance or bulk polymer resistance.
2. Drift: Not to exceed 3 percent of full scale per year.
3. Room Sensors:
a. Sensing Range: 0 to 100 percent relative humidity.
b. Accuracy of plus or minus 5 percent relative humidity.
c.
4. Duct Sensors:
a. Sensing Range: 0 to 100 percent relative humidity.
b. Accuracy of plus or minus 2 percent relative humidity.
c. Furnish with sampling chamber.
d. Element guard.
e. Mounting plate.
f.
5. Outdoor Air Humidity Sensors:
a. Sensing Range: 20 to 95 percent relative humidity.
b. Suitable for ambient conditions of minus 40 to 170 degrees F.
c. Accuracy: Plus or minus 2 percent relative humidity at 77 degrees F.
d. Element guard.
e. Mounting plate.

C. Thermostats

1. Replacement of room thermostats must meet ADA height requirements unless sensor-only type is used.
   a.
   b. Height Requirements for this project:
   c. 46 inches above finished floor, if relocation is required due to ADA height requirements.
   d.
   e. ADA Height Requirements:
   f. 48 inches above finished floor for front reach access.
   g. 54 inches above finished floor for side reach access.
   h.
2. Flat Plate Room Temperature Sensors (Gym, Multipurpose, Hallways):
   a. Provide room temperature sensor with terminal jack to allow for local operator connection to field-level terminal equipment controller.
   b. Flat plate type sensor to reduce risk of damage or valdalism.
   c. Provide additional coverplate as necessary.
3.
4. Electronic Room Temperature Sensors (Classrooms, Admin areas):
   a. Provide room temperature sensor with terminal jack to allow for local operator connection to field-level terminal equipment controller.
   b. Shall be thermistor type with 55 degree F to 95 degree F range.
   c. Unless otherwise noted, temperature sensor cover shall be flat and include a LED temperature display.
   d. Covers shall be robust, of institutional quality, suitably finished.
   e. Color white.
   f. NOT required: Thermostat setpoint dial, override button.
5.
6. An override switch shall initiate override of the night setback or unoccupied mode to normal operation when activated. A temperature setpoint dial or keypad shall also be provided with 1 degree F temperature increments. Override switch and temperature setpoint functions may be locked out, canceled or limited as to time or temperature via software. Provide lockable guards over temperature sensors in entries, corridors, gymnasiums, and multi-purpose rooms. Stainless steel flat plate temperature sensors (adjustable through programming only) may be used in these locations.
7.
8. Line Voltage Thermostats:
   a. Integral manual On/Off/Auto selector switch, single or two-pole.
   b. Dead band: Maximum 2 degrees F.
   c. Cover: Locking with set point adjustment.
   d. Load: Motor capacity rating.
   e.
9. Immersion Thermostat: Remote bulb or bimetallic rod and tube type, proportional action with adjustable setpoint and adjustable throttling range.
10.
11. Electric Low Limit Duct Thermostat:

a. Snap acting, single pole, single throw, manual reset switch tripping when temperature sensed across any 12 inches of bulb length is equal to or below set point.
b. Bulb length: Minimum 12 feet.
c. Furnish one thermostat for every 20 sq. ft of coil surface.

12.

13. Thermostatic Valve Actuator
    a. Honeywell T104 or approved equal.
    b. Direct control valve mount, internal sensor, setpoint dial.
    c. Temperature: Max 248 F
    d. Pressure: Max 150 psi
    e. EPDM disc seat
    f. Nickel plated brass cast valve body

D. Humidistats
1. Duct Humidistats:
    a. Insertion, proportioning type.
    b. Throttling range: Adjustable, 2percent, relative humidity.
    c. Operating range: 20 to 80 percent.
    d. Maximum temperature: 150 degrees F.
    e.
2. Hi/Lo Limit Humdistat:
    a. Insertion, two-position type.
    b. Throttling range: Adjustable 2 percent relative humidity.
    c. Operating range: 20 to 80 percent.
    d. Maximum temperature: 150 degrees F.

E. Differential Pressure Switches:
1. Furnish as specified in sequences of operation for status purposes in air and water applications.
2. Fully adjustable differential pressure settings.
3. UL Listed, SPDT snap-acting, pilot duty rated (125 VA minimum).
4. NEMA 250 Type 1 enclosure.
5. Scale range and differential suitable for intended application.

F. Static Pressure Sensor:
1. Non-directional sensor with suitable range for expected input, and temperature compensated.
2. Accuracy: plus or minus 1 percent of full scale with repeatability of 0.5 percent.
3. Output: 4 to 20 mA, 0-5 vDC, 0-10 vDC.
4. Building Static Pressure Range: minus 0.1 to 0.1 inches water column, minus 0.25 to 0.25 inches water column, minus 0.5 to 0.5 inches water column, minus 1.0 to 1.0 inches water column, jumper selectable.
5. Duct Static Pressure Range: 0 to 1 inches water column, 0 to 2.5 inches water column, 0 to 5 inches water column, 0 to 10 inches water column, jumper adjustable.

G. Differential Pressure Sensors:

1. Sensor range closely matched to system static pressure, minus 0.5 to 0.5 inches water column, minus 1 to 1 inches water column or 0 to 2.5 inches water column.
2. Accuracy: Plus or minus 5 percent of sensing range.

H. Carbon Dioxide Sensors:
1. Sensors designed for indoor carbon dioxide levels in accordance with ASHRAE Standard 62.
2. 4 to 20 mA. linear output over range of 0 to 2000 ppm of carbon dioxide for interface to DDC control system.
3. For duct mounted sensors furnish airtight enclosure complete with sampling tube.

I. Air Flow Switches:
1. Differential pressure type, as indicated in sequences of operation.
2. UL Listed, SPDT snap-acting with pilot duty rating (125 VA minimum).
3. Appropriate scale range and differential adjustment.
4. Adjustable sensitivity.
5. NEMA 250 Type 1 enclosure.

J. Water Flow Switches:
1. Differential pressure or electromagnetic induction type.
2. UL Listed, SPDT snap-acting with pilot duty rating (125 VA minimum).
3. Appropriate scale range and differential adjustment.
4. Adjustable sensitivity.
5. NEMA 250 Type 1 enclosure.
6. Furnish vapor proof type for chilled water applications.

K. Carbon Monoxide Detectors: Single or multi-channel, dual-level detectors, using solid-state sensors with 3 year minimum life, maximum 15 minute sensor replacement, suitable over a temperature range of 23 to 130 degrees F, calibrated for 50 and 100 ppm, with maximum 120 second response time to 100 ppm carbon monoxide.

L. Carbon Dioxide Sensor and Transmitter: Single detectors, using solid-state infrared sensors, suitable over a temperature range of 23 to 130 degrees F, calibrated for 0 to 2 percent, with continuous or averaged reading, 4 to 20 mA output, and wall mounted.

M. Oxygen Sensor and Transmitter: Single detectors, using solid-state zircon cell sensing, suitable over temperature range of minus 32 to 1100 degrees F, calibrated for 0 to 5 percent, with continuous or averaged reading, 4 to 20 mA output, wall mounted.

N. Refrigerant Detectors: Dual-level detectors, using solid-state sensors, with alarm preset for 300 ppm, alarm indicator light, alarm silence light and button, alarm test light and button, and trouble light. Provide auxiliary relay preset for 150 ppm.

O. Occupancy Sensor: Passive infrared, with time delay, daylight sensor lockout, sensitivity control, and 180 degree field of view with vertical sensing adjustment, for flush mounting.

P.

2.17 RELAYS AND SIGNAL TRANSMITTERS

A. All necessary relays and signal boosters shall be furnished to make the system a full and operable system as required by the Sequence of Operations.

B. Current sensors shall be configurable/adjustable setpoint type.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

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

C. Verify field end devices, wiring, and pneumatic tubing is installed prior to installation proceeding.

D. Verify air handling units and ductwork installation is complete and air filters are in place before installing sensors in air streams.

E. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings before installation.

F. Verify building systems to be controlled are ready to operate.

3.2 INSTALLATION

A. Install control units and other hardware in position on permanent walls where not subject to excessive vibration, temperatures between 50-90 degrees F, and humidity between 40-60 %RH.

B. Install software in control units and in operator workstation. Implement features of programs to specified requirements and appropriate to sequence of operation. Refer to Section 23 09 93.

C. Install 120 volts alternating current, 15 amp dedicated emergency power circuit to each programmable control unit.

D. Install conduit and electrical wiring in accordance with Section 26 05 03.

E. Install electrical material and installation in accordance with appropriate requirements of Division 26.

F. In mechanical rooms install bundled plastic tubing with junction boxes and raceway.

G. Install tubing concealed from view in finished, occupied spaces.

H. Install thermostats, humidistats, CO2 sensors, space temperature sensors, and other exposed control sensors after locations are coordinated with other Work.

I. Install freeze protection thermostats using flanges and element holders.

J. Install outdoor sensors indoors, with sensing elements outdoors with sun shield.

K. Provide flat plate temperature sensors in hallways, entrances, and other public areas as indicated on Drawings. Provide guards on other exposed control sensors not available in flat plate models in hallways, entrances, and other public areas as indicated on Drawings.

L. Install control panels adjacent to associated equipment on vibration free walls or freestanding supports. Use one cabinet for more than one system in same equipment room. Install engraved plastic nameplates for instruments and controls inside cabinet and engraved plastic nameplates on cabinet face. Label with appropriate equipment or system designation.

M. Install "hand/off/auto" selector switches to override automatic interlock controls when switch is in "hand" position.

N. Install conduit and electrical wiring in accordance with Section 26 05 03.

3.3 IDENTIFICATIONS

A. All controllers, switches, relays, thermostats and actuators shall be permanently tagged for identification.

B. The tagging scheme shall be reflected on the control drawings.

C. Submit proposed identification method, specifically listing each device and the identification tag to be applied.

3.4 MOUNTING HEIGHTS

A. Temperature sensors shall be installed at current ADA height requirements, 48 inches above finished floor, unless otherwise noted.
   1. 48 inches above finished floor for front reach access.
   2. 54 inches above finished floor for side reach access.

B. Humidity sensors shall be mounted between 48 and 56 inches above finished floor.

C. Room CO2 sensors shall be mounted between 48 and 56 inches above finished floor.

3.5 WIRING

A. Arrange all work so that wherever possible all serviceable or operable products are located within mechanical or electrical spaces and are accessible.

B. Install, connect and wire the items included under this Section. This work includes providing required conduit, wire, fittings, and related wiring accessories. All wiring in exposed or inaccessible areas shall be installed in EMT conduit. Plenum-rated cable may be used in concealed, accessible areas only, such as plenums above suspended ceilings or raised floors.

C. Arrange all work so that wherever possible all serviceable or operable products are located within mechanical or electrical spaces and are accessible.

D. Provide wiring between thermostats and unit heater motors, and all control and alarm wiring.

E. Provide conduit and wiring between the BAS panels and the temperature, humidity, or pressure sensing elements, including low voltage control wiring in conduit or plenum-rated cable.

F. Provide conduit and control wiring for devices specified in this Section.

G. Wiremold is not acceptable in exposed, finished area.

H. Provide conduit and signal wiring between motor starters in motor control centers and high and/or low temperature relay contacts and remote relays in BAS panels located in the vicinity of motor control centers.

I. Provide conduit and wiring between the PC workstation, electrical panels, metering instrumentation, indicating devices, miscellaneous alarm points, remotely operated contactors, and BAS panels, as shown on the drawings or as specified.

J. All wiring to be compliant with the Division 26 requirements and the NEC.

K.

3.6 MANUFACTURER'S FIELD SERVICES

A. Section 01 40 00 - Quality Requirements: Manufacturers’ field services.

B. Start and commission systems. Allow adequate time for start-up and commissioning prior to placing control systems in permanent operation.

C. Furnish service technician employed by system installer to provide commissioning support. Include a minimum of 3 days technician time.

3.7 SUBSTANTIAL COMPLETION

A. BAS contractor shall demonstrate complete and proper operation of all systems per the Sequence of Operations.

B. The demonstration shall include, but not necessarily be limited to, the following:
1. Review of the Trend Logs.

2. Complete and proper operation of control systems including simulations.
3. Access to all devices for required maintenance.
4. Review of associated graphics on the operator workstation.
5. Full commissioning process as noted under Section 01650.

C. Trend logs shall document building operation after the installation, balancing and calibration is completed and after the control system is fully operational. Setpoints, valve positions, etc. shall be adjusted to artificially induce the sequences to occur.

D. Database Backup: Provide database backup to Owner at end of training, saved to physical device (harddrive, high-capacity thumbdrive, or high-capacity CD).

E.

3.8 DEMONSTRATION AND TRAINING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Provide two separate Owner training sessions, first session prior to substantial completion, second session provided minimum 4 weeks after owner turnover maximum 8 weeks after Owner turnover.

C. Furnish basic operator training for 4 persons on data display, alarm and status descriptors, requesting data, execution commands and log requests. Include a minimum of 8 hours instructor time. Furnish training on site.

D. Demonstrate complete and operating system to Owner.

3.9 WARRANTY

A. Upon completion of the project, as defined in the Contract Conditions, a warranty period of one (1) year shall commence. The warranty shall consist of a commitment by the BAS contractor to provide, at no cost to the Owner, parts and labor as required to repair or replace such parts of the control system that prove inoperative due to defective materials or installation practices.

B. The warranty period shall include one (1) mid-year inspection trip provided by the contractor, coordinated with the owner at a date and time chosen by the owner. The mid-year inspection shall include:
1. Minimum 4 hours of on-site inspection time
2. Detailed status report provided to the owner including a description of discovered issues or problems and proposed solutions.
3. The status report shall include
    a. Cover Sheet
    b. Table of Contents
    c. Executive Summary
    d. Description of discovered issues or problems.
    e. Description of proposed solutions.

f. Site Photos.
g. Appendix for references or additional information.

C. During the warranty period the service coverage shall include 24 hour call-response and 48 hour on-site response time for emergency situations as necessary.

END OF SECTION