SAN FRANCISCO UNIFIED SCHOOL DISTRICT
FACILITIES DESIGN & CONSTRUCTION

Bid Package 1
Boiler Replacement
Balboa High School

ADDENDUM NO. 1

PROJECT: **Balboa High School**
1000 Cayuga Avenue
San Francisco, 94112

DATE: 25 MARCH 2015

OWNER: San Francisco Unified School District
135 Van Ness Avenue
San Francisco, CA 94103

DSA FILE NO.: N/A

DSA APP. NO.: N/A

Notice is hereby given to all prospective bidders that plans and specifications on the subject project are modified as hereinafter set forth. This Addendum shall be attached to and form a part of the plans and specifications. All bidders must acknowledge receipt of this addendum on the Bid Form. In case of difference with previous addenda or communications, this addendum takes precedence.

It is the responsibility of all bidders to notify all subcontractors from whom they request bids and from whom they accept bids of all changes contained in this addendum.

REPLACE SPECIFICATIONS WITH NEW SECTIONS LISTED BELOW:

Section 15900: Energy Management System
Section 15903: Control Devices
Section 15905: Sequence of Operations

CLARIFICATIONS TO BIDDERS:

1. A potential bidder posed the question as to whether a C-4 specialty contractor can perform electrical and other work related to the boiler work. The California Business and Professions Code Section 7059 allows for prime specialty contractors to sub-contract with two or more trades if said work is supplemental or incidental to the majority of the work. Bidders attention is called to the California Business and Professions Code, Section 7059 (a) and (b).
2. Clarification to Specification Section 15990, Tests and Balancing, balancing is to be provided for the cold water only. Steam pipes do not need to be balanced.

END OF ADDENDUM ITEMS

ATTACHMENTS:

Specifications:
Section 15900
Section 15903
Section 15905

SECTION 15900

ENERGY MANAGEMENT SYSTEM

PART 1 – PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide complete system of temperature controls including connections to existing SFUSD BMS network and specified herein. The System shall consist of networked controllers, performing in concert to provide the proper operation of the HVAC equipment with remote access capability via Internet.

1.2 WORK INCLUDED

A. The work under this Section of the specifications includes all labor, materials, equipment and services to provide fully operational Control System in strict accordance with these specifications and the Contract Drawings and subject to the terms and conditions of the Contract. The work in general consists of, but is not limited to, the following:

1. Provide all necessary hardware and software to meet the systems functional specifications.

2. Prepare individual hardware layouts, interconnection drawings, and software configuration (if needed) from project design data.

3. Prepare a complete point list based on the requirements of this specification and control drawings.

4. Implement the detailed design for all control objects, based on control descriptions, sequence of operation, system point list in the construction documents.

5. Complete electrical installation including wiring, raceways and power wiring, except as noted.

6. Complete the operating and maintenance manuals and 20 hours of field training for system operator’s and maintenance personnel after acceptance of the system.

7. System commissioning (including point-to-point verification, functional testing, and trend logs)

8. Full documentation for all software and equipment provided.

9. Project management for managing system installation including, but not limited to: Design installation, equipment delivery, coordination with other trades, labor management, commissioning and acceptance testing

10. Miscellaneous control wiring including, but not limited to:

    a. Wiring of thermostats

    b. Interlock wiring where shown or specified.

    c. Power wiring from designated Division 16 outlets to control components that require power

11. Provide spare parts as noted in this specification.

12. Warranty of system including all associated materials, labor, and services for period of one year from the date of final acceptance

B. Qualifications:

1. Submit written resumes of key personnel proposed on the project.

2. The following minimum qualifications are required from the Controls contractor:

    a. Have comprehensive local service and trained support personnel capable of giving instruction and provide emergency maintenance on the system - including all software, firmware and hardware components.

    b. Have access to local supplies of essential expendable and spare parts.

    c. Have a proven record of successful local installation and maintenance of control systems for a minimum period of 4 years. Provide list of all local installations with District contact names and phone numbers.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Section 15010: Mechanical General Requirements

B. Section 15903: Energy Management System – Field Devices

C. Section 15905: Sequence of Operation

D. Division 16: Electrical

1.4 SUBMITTALS

A. General:

1. Indicate with bid known substitutions and deviations from requirements of Contract Documents. Substitutions shall be submitted in accordance with the requirements of 15010.

B. Product Data:

1. Provide technical bulletins and catalog data for all equipment and system components. Clearly identify, by use of symbol or tag number, the service of each item. All irrelevant information shall be marked out leaving only pertinent data.

C. Shop Drawings:

1. Provide all drawings in AutoCad release 2010 compatible format. Shop drawing submittals shall include sufficient data to indicate complete compliance with Contract Documents. Submissions in form of drawings, brochures, bulletins, catalog data, and/or narrative descriptions. As a minimum requirement submit:

   a. Symbol and abbreviation lists

   b. System block diagram showing quantity and location of controller and other major System Components

   c. Control diagrams for all systems controlled. Controls shall be shown on system flow diagrams.

   d. Floor plans indicating all controlled equipment and component locations.

   e. Interfaces (software and hardware) with equipment provided in other sections of specifications.

   f. Electrical drawings that show all system internal and external connection points, terminal block layouts, and terminal identification.

   g. Narrative description of operation for each system, enumerating and describing the function of each component. Include alarm and emergency sequences, and equipment interlocks.

   h. Detailed bill of materials

   i. Valve and Damper Schedule: Provide identification numbers, location, system, dimensions and performance data.

j. Device mounting details - include as a minimum:

(1) Sensing elements in ducts or casings

(2) Sensing elements in piping

(3) Variable volume pressure sensor

k. Other information as requested herein

l. Drawings shall be submitted in 11"x 17" (ANSI B) size.

m. Cover sheet, table of contents, and symbol sheets

D. As-Built

1. As-builts will consist of updated documentation as listed above and additional documentation as follows:

a. Testing, commissioning, and acceptance reports used to meet the commissioning requirements

b. Printed and electronic Operation and Maintenance (O&M) manuals

c. Warranty contact information

d. Programming documentation

e. Copy of entire software database

f. Software licenses

g. Guarantees and warranties

2. The EMS contractor shall install within each control cabinet, as-built documentation specific to that control panel

3. Project-specific software and documentation shall become SFUSD’s property. This includes, but is not limited to;

a. Record drawings and documentation

b. Database

c. Application programming code

E. Samples:

1. Space temperature sensors

2. All devices mounted on finished surfaces

F. Quality Control Submittals:

1. UL listing compliance certificates for equipment

2. Final calibration, commissioning and testing reports at completion of project

1.5 OWNER'S MANUALS

A. General:

1. Submit copies (hard copy and electronic media) of owner's manuals for review. Refer to Section 15010.

2. Update manuals with modifications made to system during guarantee period. Provide replacement pages or supplements in quantity stated above.

3. On the first page of each manual identify with project name, manual title, owner's name, engineer's name, contractor's name, address and service phone number, and person who prepared manual.

B. One hardcopy of operating manual to serve as backup and reference manual for all aspects of the system. As a minimum include the following:

1. Control flow diagrams.

2. Sequence of operation for automatic and manual operating modes. The sequences shall cross reference the system point names.

3. Description of manual override operation of control points

4. System manufacturer's complete operating manuals.

5. Complete as-built installation drawings for each system. Provide all drawings in AutoCad release 2010 compatible format. Drawings shall be on CD-ROM.

6. Overall system electrical power supply scheme indicating source of electrical power for each system component. Indicate which components are on emergency power and indicate all battery backup provisions.

7. Overall system shielding and grounding scheme indicating all major components and ground paths

8. Photographs and drawings showing installation details and locations of equipment

9. Charts showing normal operating conditions at significant points such as electrical test points

10. Routine preventive maintenance procedures, corrective diagnostic troubleshooting procedures, and calibration procedures

11. Parts lists with manufacturer's catalog numbers and ordering information.

12. Lists of ordinary and special tools, operating materials supplies and test equipment recommended for operation and servicing.

13. Manufacturer's operating set up, maintenance and catalog literature for each piece of equipment.

14. Maintenance and repair instructions

15. Recommended spare parts

1.6 QUALITY ASSURANCE

A. Comply with all current governing codes, ordinances and regulations, as well as with requirements of NFPA, UL and all other applicable codes.

PART 2 – PRODUCTS

2.1 GENERAL

A. It is SFUSD's goal to establish uniform standards for the installation of controls in new construction, modernization, and retrofits. All contractors are expected to abide by these standards.

B. The SFUSD Energy Management System (EMS) uses the Niagara Framework software platform, manufactured by Tridium®, Inc., to manage and control more than 100 District facilities over the Internet using a standard web browser. The District is transitioning from a Tridium® Niagara R2 platform with Circon field controllers to a Tridium® Niagara^{AX} platform with Distech field controllers. All new installations **must** use Tridium® Niagara^{AX} with Distech field controllers.

C. Questions regarding these EMS standards and the design and specification of any new system or upgrade to an existing system shall be directed to:

1. : (ADD #1) SFUSD Buildings and Grounds EMS Supervisor [T] 415-695-5508

D. Any upgrade or addition to an existing system shall be fully integrated to match

the existing graphical user interface via the Tridium Niagara Framework and routed through the Wide Area Network of the SFUSD Information Technology (ADD #1) Department. It is SFUSD's goal to establish uniform standards for the installation of controls in both new construction and retrofits.

2.2 DEFINITIONS

A. JACE: Java Application Control Engine.

B. Legacy System: Some schools are currently controlled by some combination of Solidyne Corporation controllers, LON-based Circon 200 controllers, or LON-based Circon 300 controllers, controlled locally, through a dial-up, or through a JACE controller(s) via Ethernet. In the remainder of the District Standards, these configurations will be referred to as a "Legacy System." The SFUSD will not permit any further installations or modifications of any Legacy System, other than replacing and upgrading all components to the AX/Distech System described below.

C. AX/Distech System: Some schools are currently controlled by LON-based Distech controls equipment, manufactured by Distech Controls, and connected to the SFUSD IT Department's Ethernet network through Tridium® NiagaraAX JACE controller(s) and associated Ethernet network equipment. In the remainder of the District Standards, this configuration will be known as the AX/Distech System. All new installations, replacement installations, and upgrades must use the AX/Distech System. (ADD #1)

2.3 SYSTEM INTEGRITY

A. All new installations, replacement installations, and upgrades must use the AX/Distech System.

B. No substitutions will be permitted without prior review and approval by the District Project Manager, the District Architect, and SFUSD Buildings and Grounds. (ADD #1) Substitutions shall require specific project-by project, value-based submissions addressing at a minimum first-cost differences, performance improvements, long term service effects, and ability to integrate with the current software framework, and shall be reviewed and approved in writing by the District Project Manager, the District Architect, and the EMS Supervisor at the SFUSD Buildings and Grounds Dept. Any substitutions made without this approval must be replaced with approved parts at no cost to the District.

C. All new field controller componentry shall be Distech Controls, and comply with Echelon's LonTalk® protocol ANSI/EEA 709.1 control networking standard.

D. Integration with the Tridium® NiagaraAX Framework shall be accomplished through an EMS contractor-installed Tridium® NiagaraAX JACE 3E, 6E or 7 as specified in Section 00013. No legacy JACE 2s or 6s will be permitted. The JACE must be connected to the SFUSD intranet via the school's Ethernet

connection. All JACEs installed must comply with the Tridium® NiagaraAX Compatibility Statement (NiCS) with the following requirements: Station Compatibility In= All; Station Compatibility Out = All; Tool Compatibility In = All; Tool Compatibility Out = All. No restricted-license JACEs are allowed. No substitutions are allowed during either design or construction.

E. If the project involves the removal and reinstallation of existing mechanical systems that are tied into existing Circon 300-series or Distech Controls controllers, and there are no changes necessary, a Buildings and Grounds representative must be consulted to determine whether new controls must be installed.

F. If the installing contractor removes any controllers during a retrofit, including Circon, Distech, or Tridium® parts, they must salvage, protect, and return the controllers and all related parts to Buildings and Grounds as soon as these controllers are taken out of service. (ADD #1)

G. The EMS contractor shall install the JACE, the LON communications trunk from JACE to Distech controllers and communications trunk from the JACE to the District's existing Ethernet communication network. The EMS contractor shall coordinate this aspect of the installation with the Information Technology Department of the District.

H. All JACE, router, and EMS server setup and programming, including graphics, shall be accomplished by the EMS contractor. The EMS contractor shall supply all necessary documentation to the District and perform all check-out and commissioning as necessary to ensure a complete and fully functional system.

I. The software version to be installed on the Tridium® NiagaraAX JACE must match the version on the existing Tridium® NiagaraAX server. The software version installed shall be at or higher than the Tridium® June 2013 release. If the contractor needs to upgrade the version of Tridium® NiagaraAX on the JACE and server, that must be done by the contractor at no additional cost to the District.(ADD #1)All graphics, programming, trending, and operator adjustments of Tridium Vykon Release 2 JACE shall be identical to the greatest extent possible to the District's existing currently installed EMS server and JACE operations. The EMS contractor shall examine and replicate existing installed systems to the greatest extent possible

J. The installing contractor must provide a fully functional graphical user interface (GUI) that matches existing systems. Any upgrade or addition to an existing system shall also be fully integrated to match the existing graphical user interface. Contractors must consult with the SFUSD Buildings & Grounds EMS Supervisor to obtain examples of the appropriate existing graphical user interface and the District and the District's representative must approve the EMS

contractor's proposed format before the EMS contractor may commence work.

K. All programming logic will be done at the local Distech field controller level. The controller must be able to operate on a standalone basis. Dumb points devices shall not be used in place of programmable field controllers. The JACE must act as a supervisory controller only. The JACE will be used to provide scheduling and transfer of alarms and trends to the Web supervisor.

L. If a site is occupied during construction, the EMS contractor must consult with the District's Project Manager, Construction Manager and Buildings and Grounds to minimize disruption of services to building occupants, and advise the District's Project Manager, Construction Manager, and Buildings and Grounds about any changes to the system as they are made. (ADD #1)

2.4 CONTROLLERS

A. Controllers: The EMS contractor shall furnish and install Distech Controllers for the specific application in which they are intended by the manufacturer. Each controller shall be equipped with a manual override switch for all analog and digital output points. All controllers shall be installed within a Hoffman Nema Type 1 hinged- cover enclosure with back plate. The EMS contractor shall install a 120Volt, 20Amp grounded duplex receptacle within each control panel. All internal wiring shall be enclosed within a covered plastic raceway

PART 3 – EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. All electrical work performed in the installation of the control system as described in this specification shall be per the National Electrical Code (NEC) and per applicable state and local codes. Where exposed, conduit shall be run parallel to building lines properly supported and sized at a maximum of 40% fill. In no cases shall field installed conduit smaller than ½" trade size be allowed. Where conductors are concealed, cable rated for use in return air plenums shall be used.

3.2 CLEANING

A. This contractor shall clean up all debris resulting from his or her activities daily. The contractor shall remove all cartons, containers, crates, etc. under his control as soon as their contents have been removed. Waste shall be collected and placed in a location designated by the Construction Manager or General Contractor.

B. At the completion of work in any area, the Contractor shall clean all of his/her work, equipment, etc., making it free from dust, dirt and debris, etc.

C. At the completion of work, all equipment furnished under this Section shall be

checked for paint damage, and any factory finished paint that has been damaged shall be repaired to match the adjacent areas. Any metal cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

3.3 PROTECTION

A. The Contractor shall protect all work and material from damage by his/her work or workers, and shall be liable for all damage thus caused.

B. The Contractor shall be responsible for his/her work and equipment until finally inspected, tested, and accepted. The Contractor shall protect his/her work against theft or damage, and shall carefully store material and equipment received on site that is not immediately installed. The Contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.4 FIELD QUALITY CONTROL

A. All work, materials and equipment shall comply with the rules and regulations of applicable local, state, and federal codes and ordinances as identified in Part 1 of this Section.

B. Contractor shall continually monitor the field installation for code compliance and quality of workmanship. All visible piping and or wiring runs shall be installed parallel to building lines and properly supported.

C. Contractor shall arrange for field inspections by local and/or state authorities having jurisdiction over the work.

3.5 OWNER TRAINING

A. Provide training for designated District staff. All training shall be at the project site. Training shall enable the staff to understand the following:

1. Control system architecture and configuration

2. Location of all equipment and system components

3. System operation and sequences

4. System drawings and Operation and Maintenance manuals

B. The Contractor shall provide five (5) copies of an operator's manual describing all operating and routine maintenance service procedures to be used with the temperature control system supplied. Contractor shall instruct the District's designated representatives in these procedures during the startup and test period. The duration of the instruction period shall be no less than 20 hours,

during normal working hours.

3.6 CALIBRATION AND ADJUSTMENTS

A. After completion of the installation, perform final calibrations and adjustments of the equipment provided under this Contract. Adjust and validate all sensors, valves, dampers, relays, controllers, etc.

3.7 TECHNICAL SUPPORT

A. Contractor shall be available to respond to system failure within four (4) hours of notification between the hours of 7 a.m. and 10 p.m.

3.8 FUNCTIONAL TESTING

A. Startup and testing shall be completed by the EMS contractor prior to notifying the District of the system demonstration. The District may participate and/or witness the startup and testing. As such, provide the District with a startup and testing schedule.

B. Contractor shall provide qualified test personnel who will be familiar with the equipment and software used for this contract.

C. Test personnel shall be responsible for conducting tests without harm to persons working in the building and without damage to any installed equipment, materials or finishes.

D. Contractor shall provide all test instruments and shall demonstrate recent calibration.

E. Enable control systems and verify each input and output device's calibration as indicated in the Table below:

Table 1

Reporting Accuracy

Measured Variable	End-to-End Accuracy
Air and Water Temperature	±1ºF
Relative Humidity	±5% RH
Water Flow	±5% of full scale
Airflow	(10% to 100% of scale) ±10% of full scale

Air Pressure (ducts)	±0.1 in. w.g.
Air Pressure (space)	±0.01 in. w.g.
Water/Steam Pressure	±2% of full scale
Electrical (Amps, Volts, Watts, Power Factor)	±1% of reading
Carbon Monoxide (CO)	±5% of reading
Carbon Dioxide (CO2)	±50 ppm

F. Verify communication between all points and controllers and between controllers and operator station.

G. Verify that binary output devices such as relays, solenoid valves, two-position actuators and control valves, and magnetic starters, operate properly and that normal (or power fail) positions are correct.

H. Verify that all analog output devices are functional and that direction and normal positions are correct. Check control valves and automatic dampers to ensure proper action and closure. Make necessary adjustments to valve stem and damper blade travel as necessary.

I. Verify that systems and equipment operates according to the specified sequences of operation. Simulate and observe each operational mode by overriding and varying inputs and schedules. Verify correct response to forced sensor deviation.

J. Simulate a power failure of the entire EMS and ensure systems are automatically operational when power is restored.

K. Prepare a log documenting all startup and testing with technician's initials, data and time, certifying each device and sequence has been calibrated and tested.

3.9 DEMONSTRATION

A. Prior to District acceptance, perform the following operational tests to demonstrate compliance with the specification after and in addition to tests specified above.

B. The District or their designated representative will be present to observe and review system demonstration. Notify the District at least ten (10) days before system demonstration begins.

C. Demonstrate actual field operation of each sequence of operation as specified and approved.

D. Demonstrate calibration and response of any input and output points requested by the District.

E. Provide and operate test equipment required to prove proper system operation.

F. Demonstrate compliance with sequences of operation through each operational mode.

G. Tests that fail to demonstrate proper system operation shall be repeated after Contractor makes necessary repairs or revisions to hardware or software to successfully complete each test.

H. Demonstrate power fail and restoration.

3.10 CONTROL SYSTEM ACCEPTANCE:

A. The EMS shall not be accepted until completed demonstration forms, checklists, and logs are submitted and approved as required herein.

B. Subsequent to the satisfactory start up, testing, demonstration, and receipt of the forms, checklists, and logs, the District will recommend the acceptance of the control system.

C. Warranty will commence upon successful completion of the acceptance tests and procedures to the District's satisfaction.

D. Controls Contractor shall provide assistance to Mechanical Contractor during system balancing as described in Section 15990.

END OF SECTION 15900

Addendum #1 March 23, 2015

SECTION 15903

CONTROL DEVICES

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK

A. General: The control system field devices shall include, but not limited to the following:

1. Sensors
2. Thermostats
3. Switches
4. Relays
5. Actuators
6. Valves
7. Dampers

B. Refer to Section 15900: Energy Management System.

C. Refer to Section 15905: Sequence of Operation.

PART 2 – PRODUCTS

2.1 FIELD CONTROL DEVICES

A. General:

1. It is the intent of the District to maintain a minimum spare parts inventory and minimize the technical expertise required for all field maintenance work. The EMS contractor shall strictly adhere to installing the components detailed below. In the event the manufacturers introduce newer component models, the EMS contractor shall notify the District, and the District shall determine whether they will be acceptable. It shall not be the EMS contractor's responsibility to supply additional inventory components unless the contractor furnishes and installs alternate equipment accepted by the District, in which case the contractor shall provide 10% spare parts of each component with a minimum of one (1)

B. Temperature Sensors

1. Temperature Sensors: The EMS contractor shall furnish and install outside air, space, duct, and water temperature sensors that are appropriate (ADD #1) for the specific application requirement. Where indicated on the project plans, furnish and install stainless steel wall plate sensors in areas of high traffic or where tampering is likely to occur.

2. Duct sensors shall be rigid or averaging as shown. Averaging sensors shall be a minimum of 5 feet in length.

3. Immersion sensors shall be provided with a separable stainless steel well. Pressure rating of well is to be consistent with the system pressure in which it is to be installed.

4. Space sensors shall be equipped with set-point adjustment, override switch, display, and/or communication port as shown on the drawings.

5. Provide matched temperature sensors for differential temperature measurement. Differential accuracy shall be within 0.2 deg F.

C. Static Pressure Sensors - Water

1. Sensor shall have linear output signal. Zero and span shall be field-adjustable.

2. Sensor sensing elements shall withstand continuous operating conditions plus or minus 50% greater than calibrated span without damage.

3. Water differential pressure sensor shall have stainless steel diaphragm construction, proof pressure of 150 psi minimum. Over-range limit (DP) and maximum static pressure shall be 3,000 psi. Transmitter shall be complete with 4-20 ma output, required mounting brackets, and five-valve manifold. Mount in a location accessible for service.

D. Static Pressure Sensors – Air

1. Duct static pressure sensors shall be differential pressure type. The sensor range shall be closely matched to the system static pressure, 0 to 2.5 inches.

2. Sensor accuracy shall be plus or minus 2% of the sensing range.

E. Differential Pressure Switches

1. Differential pressure switches shall be UL listed, SPDT snap-acting, pilot

duty rated and shall have scale range and differential suitable for intended application – with NEMA 1 enclosure.

F. Steam Pressure Sensors

1. The EMS contractor shall furnish and install a steam pressure sensor in the main steam header of steam boiler systems. The sensor shall be a 4-20mA .(ADD #1) The range of the sensor shall be approximately twice that of the expected operating steam pressure.

G. Carbon Dioxide Sensors

1. Sensor shall use non-dispersive infrared technology, with sensor protected by membrane filter that is permeable to CO2. Signal processor shall automatically compensate for drift and shall be self-testing and shall not need recalibration more frequently than once per year.

   a. Operating range to be 0-2000 part per million CO2.

   b. Output signal to be 1-10 VDC linear within operating range.

   c. Shall be suitable for duct mounting.

   d. Response time not to exceed 30 seconds.

   e. Accuracy to be + /-100 ppm.

   f. Repeatability better than + /-20 ppm.

   g. Shall be listed as meeting FCC Part 15.

H. Current Switches

1. Current-operated switches shall be self-powered, solid state with adjustable trip current. The switches shall be selected to match the current of the application and output requirements of the DDC system.

I. Relays

1. Control relays shall be UL listed plug-in type with dust cover. Contact rating, configuration, and coil voltage suitable for application.

2. Time delay relays shall be UL listed solid-state plug-in type with adjustable time delay. Delay shall be adjustable plus or minus 200% (minimum) from set-point shown on plans. Contact rating, configuration, and coil voltage suitable for application. Provide NEMA 1 Type enclosure when not installed in local control panel.

J. Transformers and Power Supplies

1. Control transformers shall be UL listed, Class 2 current-limiting type, or shall be furnished with over-current protection in both primary and secondary circuits for Class 2 service.

2. Unit output shall match the required output current and voltage requirements. Current output shall allow for a 50% safety factor. Output ripple shall be 3.0 mV maximum Peak-to-Peak. Regulation shall be 0.10% line and load combined, with 50 microsecond response time for 50% load changes. Unit shall have built-in over-voltage protection.

3. Unit shall operate between 0 deg C and 50 deg C.

4. Unit shall be UL recognized.

K. Motorized Dampers

1. Dampers shall have linear flow characteristics and shall be parallel or opposed blade as specified.

2. Frames shall be 13 gauge galvanized steel channel or 1/8” extruded aluminum with reinforced corner bracing.

3. Blades shall not exceed 8” width or 48” in length. Blades shall be suitable for medium velocity (2000 fpm) performance. Blades shall be not less than 16 gauge.

4. Shaft bearings shall be as recommended by manufacturer for application, oil impregnated sintered bronze, or better.

5. Blade edges and frame top and bottom shall have replaceable seals of butyl rubber or neoprene. Side seals shall be spring-loaded stainless steel. Blade seals shall leak no more than 10 cfm per sq ft at 4” WC differential pressure.

6. Blades shall be airfoil type suitable for wide-open face velocity of 1500 fpm.

7. Sections shall not exceed 48” – 60”. Each section shall have at least one damper actuator. Dampers shall have exposed linkages.

L. Electronic Damper / Valve Actuators.

1. In the event the specific controls project does not encompass the entire building, the BMS contractor shall be responsible for ensuring that any pneumatic tubing that is removed or abandoned does not affect the compressed air system for the remainder of the building.

2. The EMS contractor shall furnish and install electronic actuators for all dampers and valves. Actuators shall be 24Vac, 0 – 10V or 4-20mA, modulating or two-position, as applicable, with spring return as manufactured by Belimo.

3. The EMS contractor shall ensure the proper fail-safe mode for each valve and damper controlled.

4. The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the rotation of the actuator.

5. Where shown, for power-failure/safety applications, an internal mechanical, spring return mechanism shall be built into the actuator housing.

6. All rotary spring return actuators shall be capable of both clockwise and counter clockwise spring return operation. Linear actuators shall spring return to the retracted position.

7. Proportional actuators shall accept a 0-10 VDC or 0-20 ma control signal and provide a 2-10 VDC or 4-20 ma operating range.

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

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

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

11. Actuators shall be provided with a conduit fitting and a minimum 1m electrical cable and shall be pre-wired to eliminate the necessity of opening the actuator housing to make electrical connections.

12. Actuators shall be Underwriters Laboratories Standard 873 listed.

13. Actuators shall be designed for a minimum of 60,000 full stroke cycles at the actuator's rated torque.

M. Control Valves

1. Control valves shall be two-way or three-way type for two-position or

modulating service as scheduled or shown.

2. Close-off (differential) Pressure Rating: Valve actuator and trim shall be furnished to provide the following minimum close-off pressure ratings:

   a. Water Valves:

      (1) Two-way: 150% of total system (pump) head.

      (2) Three-way: 300% of pressure differential between ports A and B at design flow or 100% of total system (pump) head.

3. Water Valves

   a. Body and trim style and materials shall be per manufacturer's recommendations for design conditions and service shown, with equal percentage ports for modulating service.

   b. Sizing Criteria

      (1) Two-position service: Line size.

      (2) Two-way modulating service: Pressure drop shall be equal to twice the pressure drop through heat exchanger (load), 50% of the pressure difference between supply and return mains, or [5] psi, whichever is greater.

      (3) Three-way Modulating Service: Pressure drop equal to twice the pressure drop through the coil exchanger (load), [5] psi maximum.

      (4) Valves 1/2" through 2" shall be bronze body or cast brass ANSI Class 250, spring loaded, Teflon packing, quick opening for two-position service. Two-way valves to have replaceable composition disc, or stainless steel ball.

      (5) 2-1/2" valves and larger shall be cast iron ANSI Class 125 with guided plug and Teflon packing.

   c. Water valves shall fail normally open or closed as scheduled on plans or as follows:

      (1) Heating coils in air handlers - normally open.

      (2) Chilled water control valves - normally closed.

      (3) Other applications - as scheduled or as required by sequence of operation.

4. Zone valves shall be sized to meet the control application and they shall maintain their last position in the event of a power failure.

N. Local Control Panels

1. All indoor control cabinets shall be fully enclosed NEMA 1 Type construction with [hinged door], key-lock latch, and removable sub-panels. A single key shall be common to all field panels and sub-panels.

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. Provide on/off power switch with over-current protection and main air gauge for control power sources to each local panel.

PART 3 – EXECUTION

3.1 SEE 15900 AND 15905

END OF SECTION 15903

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SECTION 15905

SEQUENCE OF OPERATIONS

PART 1 – GENERAL

1.1 DESCRIPTION

A. The work of this section shall include, but is not limited to, the following:

B. Supply and install necessary software, programming, sensing, controlling and controlled devices, piping, wiring and commissioning of automatic control systems, so as to provide a complete control system and meet requirements of control sequences specified.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 15010: General Provisions.

B. Section 15900: Energy Management Systems

C. Section 15903: Energy Management Systems – Field Devices

1.3 GENERAL

A. All equipment and system sequence programming of Distech controllers shall be identical to the District's existing standard sequences of operation. The EMS contractor shall program all controllers to reflect the existing sequence of operations at that site. The EMS contractor must consult with Buildings and Grounds about the appropriate sequence of operations for each site. Any deviation to the existing sequence of operations must be approved by Buildings and Grounds. (ACD #1)

B. Set points shall be remotely adjustable via the OWS.

C. Controllers and or control functions / Control "loops" are to incorporate PID algorithms. Determine and apply the PID values to each loop to ensure proper control and system / loop stability.

D. All System data and variables are to be "readable" and have the capability to be used by all features and applications of the system.

E. Do not implement any changes to these sequences, however minor, without submitting the changes for approval in narrative form. Diagrammatic and programming language or code submissions will not be reviewed or approved.

G. Provide customized control strategies and control sequences and define

appropriate control loop algorithms and choose the optimum loop parameters for loop control. All control loops shall be tuned to stabilize within plus or minus 1 percent of setpoint within 5 minutes of setpoint change or startup.

H. Safety devices shall be hardwire interlocked with “hand” and “automatic” positions in series with motor controller holding circuit.

I. Start up sequences and automatic control sequences as described shall operate in both automatic and manual modes.

J. Fire and life safety sequences shall override other automatic control sequences including hardwired safety devices.

K. Reset schedules and setpoints shown in sequences are for initial programming and start up. During system commissioning the reset schedules and setpoints shall be fine tuned to obtain desired comfort, energy and life safety system results.

L. The output of the reset schedules should be limited between maximum and minimum values. The intent of the reset schedules indicated is that the range of the output be limited between the minimum and maximum values indicated in the reset schedules.

M. All functions which use analog points to switch equipment on and off (e.g. fans, pumps) must be programmed with dead bands, and if necessary, time delays to prevent short cycling of equipment.

N. Starting of pumps shall have built in time delays where valve is required to open or close prior to pump pressure build up.

1.4 MODE OF OPERATION DEFINITION

A. Occupied Mode: The system shall operate in occupied mode whenever the occupancy schedule indicates an occupied time period or when any zone control space temperature sensor override device is in the override position.

B. Setback Mode: The system shall operate in setback mode when an AHU is in unoccupied mode and a space temperature sensor indicates temperature below the unoccupied heating setpoint.

C. Warm Up Mode: The system shall operate in warm up mode when the system is running prior to scheduled occupancy time as determined by the optimum start program and the space temperature is lower than the occupied heating setpoint.

D. Cool Down Mode: The system shall operate in cool down mode when the system is running prior to scheduled occupancy time as determined by the optimum start program and the space temperature is higher than the occupied cooling setpoint.

E. Unoccupied Mode: The system shall not operate whenever the operating schedule indicates an unoccupied time period unless mode is overridden by operator input.

F. Fire Mode: The system shall run in this mode based on input from the Fire Alarm System. This mode shall have priority over all other control modes.

PART 2 – PRODUCTS

2.1 NOT USED

PART 3 – EXECUTION

3.1 STEAM BOILER SYSTEMS:

A. An optimal start program enables the heating system. The optimal start program adjusts the actual start time based upon building space and outside air temperatures. The lead boiler is automatically determined based upon boiler run times. The boiler with the least amount of runtime is selected as the lead boiler when the boiler schedule changes state to the occupied mode. The lead boiler is locked in while the boiler schedule is in the occupied mode to prevent the system from changing the lead boiler while in the occupied mode.

B. When the actual time of day equals the optimal target start time, the system is placed in the occupied mode of operation, at which time the vacuum or condensate pump(s) are started after an adjustable time delay, and after the boiler on delay, the lead boiler is enabled. The lead boiler stays enabled until the steam header pressure exceeds the steam pressure setpoint by an adjustable deadband, at which time the lead boiler is disabled. If the steam pressure falls below the lead boiler pressure setpoint by an adjustable deadband, the lead boiler is re-enabled. After an adjustable time period, If the steam pressure falls below the lag boiler on pressure setpoint by an adjustable deadband, the lag boiler is enabled.

C. During occupied mode, should the representative space temperatures reach their setpoints and the outside air temperature is above the boiler system on temperature setpoint, the heating system is disabled and shut down according to the shut down sequence. When space and outside air temperatures fall below their setpoints, the boiler system shall be started as outlined above.

D. If any boiler fails, the lag boiler shall maintain the failed lead boiler setpoint schedules.

E. Once the time of day equals the scheduled stop time, the boiler system is disabled. After an adjustable time delay, the system pumps are disabled.

F. A combustible gas detector shall shut down the boilers and alarm the EMS if gas is detected in high enough concentrations in the boiler room

G. An emergency stop button located near the boiler room entrance shall shut down the boilers and alarm the EMS if depressed.

H. The minimum required monitoring and control points shall include:

Each Boiler	Miscellaneous
Start/Stop	System steam pressure
Status	Condensate return temperature
High limit	Condensate/vacuum pump start/stop
Flame failure	Outside air temperature
Low water	Average building temperature
High gas pressure	Gas Detector Alarm
Low gas pressure	Manual emergency stop switch status
	* HX steam valve
	* HX hot water supply temperature
	* as applicable

I.

(ADD #1)

END OF SECTION 15905

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