ADDENDUM NUMBER ONE

University of South Carolina
USC Beaufort HVAC Repair Project
Owner's Project Number: H36-9513-A / CP00367717

PREPARED BY: Dwight Cathcart (USC Project Manager)

DATE OF ISSUE: August 29, 2013

TO: ALL BIDDERS OF RECORD

The following items shall take precedence over the drawings and specifications for the above named project and shall become a part of the contract documents. Where any item called for in the specifications, or indicated on the drawings, is not supplemented hereby, the original requirements shall remain in effect. Where any original item is amended, voided or superseded hereby, the provisions of such item not specifically amended, voided or superseded shall remain in effect.

BIDDER SHALL ACKNOWLEDGE RECEIPT OF ADDENDUM IN THE SPACE PROVIDED ON THE BID FORM. FAILURE TO DO SO MAY CONSTITUTE BID NONRESPONSIBLE.

This addendum consists of two (2) pages, and **TWO (2) attachments:**

1. Pre-Bid meeting sign in Sheet (1) page, Pre-Bid meeting Sign in Sheet from Roofing Project (2) pages, and Specifications Section 23 09 00 Temperature Controls / BACS.

I. GENERAL CLARIFICATION

1. See attached pre-bid sign in sheet for your records.

2. Bid closing location has been changed to 801 Carteret Street, Beaufort College Building, Room 103, Beaufort SC 29902. Date and time to remain the same, 9-5-2013 at 1:30 pm.

3. See attached pre-bid sign in sheet from previous roof repair project.

4. See attached Specification Section 23 09 00 for Temperature Controls / BACS.

5. Contractor responsible for cleaning refrigerant from all removed units freeing disposed units of any hazardous materials. Contractors to dispose of refrigerant and removed HVAC units. Note this is a change from the information put out during Pre-Bid meeting.

6. Contractor is responsible for submitting all necessary paperwork to apply for utility rebates through the SCE&G Energy Wise Program. The Unitary HVAC incentives can be found at the following address. http://www.sceg.com/NR/rdonlyres/9EBD726F-C879-44B1-8340-5FD52F4EB00A/0/HVAC_Unitary_Incent_v10.pdf

7. Last day for RFI's is August 29, 2013 COB.

END OF ADDENDUM NUMBER ONE

University of South Carolina Pre Bid Sign In Sheet

Columbia, South Carolina

Project Name: USCB Roof Repairs
Project Number: H36-9513
Pre Bid Date & Time: August 27, 2013 @ 11AM

Name	Company	Address	Phone #	Email
Ted S Bourne	C.E. Bourne & Co	PO Box 614 Greenwood, SC 29648	864-223-0188	ted@cebourne.com
Wade Lancaster	Metalcrafts, Inc.	PO Box 1665 Savannah, GA	(912) 236-0615	WLancaster@Metalcraftsinc.com
MIKE MOORSHEAD	ROOFERS SUPPLY OF GREENVILLE	34 CONSTRUCTION DR. PIEDMONT, SC 29673	864-299-0055	mikem@roofersupplyinc.com
Scott Miles	Roofco Inc	1345 N Pike Rd Sumter SC. 29151	803 775 8560	Roofco@sc.rr.com
Paul Cromer	Fort Roofing	Sumter, SC 29150 1414 Oakland Ave	803-773-9391	Jpcromer3@sc.twcbc.com
WILLIAM ZARKADAS	SOUTHERN ROOF & CARE LLC	1210 Honey Hill Rd PO Box 1279 Hardeeville SC 29927	843-784-7676	WILLIAM@SOUTHERNROOF.COM
Donny Coleman	Southern Roof & Wood Care	1210 Honey Hill Rd Hardeeville SC	843-784-7676	donny@southernroof.com
KELLY SULLIVAN	RPI	429 LONGWOOD DR. RICHMOND HILL, GA 31324	912-657-0543	KSULLIVAN@RPIROOF.COM
Richard Ryan	Coastal Roofing Co. Inc.	2234 Westchester Dr Charleston, SC 29414	843 906-7151	rryansc@gmail.com

*Please make sure you list your company name as registered with LLR.

* By signing and providing your email address, you are authorizing the University of South Carolina to send you information electronically.

University of South Carolina Pre Bid Sign In Sheet

Columbia, South Carolina

Project Name: USCB Roof Repairs
Project Number: H36-9513
Pre Bid Date & Time: August 27, 2013 @ 11AM

Name	Company	Address	Phone #	Email
Dwight Cathcart	USC Columbia Main Campus	743 Greene St. Columbia SC. 29208	803-240-5394	dcathcar@fmc.sc.edu
[signature]	USC Beaufort	801 Carteret 29902	843-521-4140	hjholmes@uscb.edu
Dwight Jones	Essex	4611 Hand Scrabble Road Columbia, SC	404/365-9482	djones@Essexco.com
MIKE PARROTT	USCB	1 University Blvd Bluffton SC 29909	843-208-8040	RPARROT@USCB.EDU
BILL BELTZ	NEWTECH	6 Ghost Pond Bluffton, SC 29910	8437063760	WFBELTZ@AOL.COM
Lance Barron	Essex	4611 Hand Scrabble Rd - Columbia SC	404-365-9482	lbarron@essexco.com

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* By signing and providing your email address, you are authorizing the University of South Carolina to send you information electronically.

University of South Carolina Pre Bid Sign In Sheet

Columbia, South Carolina

Project Name: HVAC Modifications & Upgrades
Project Number: H36-9513-A
Pre Bid Date & Time: August 27, 2013 @ 1:30PM

Name	Company	Address	Phone #	Email
ALEX DRAFTS	W.O. BLACKSTONE	1841 SHOP RD. COLA, SC 29201	803-360-6942	adrafts@wo blackstone.com
BRYAN SMYTHE	JOHNSON CONTROLS	SEA RAY DRIVE N. CHARLESTON SC.	843-725-9187	MARK.A.Zip @JCI.com
Dwight Cathcart	USC Columbia Main Campus	745 Greene St Columbia SC 29208	803-240-5314	dcathcar@fmc.sc.edu
MIKE PARROTT	USCB	1 UNIVERSITY BLVD BLUFFTON SC 29909	843-208-8040	RPARROT@USCB.EDU
J.D. Harvey	USCB	25 W Campus Str. Bluffton, SC 29910		
Jackie Holmes	USCB	801 CARETREET 29902	843 368-1296	hjholme1@uscb.edu
Dwight Jones	Essex	4611 Hard Scrabble Rd Columbia, SC	404/915-5413	djones@essexco.com

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23 09 00

TEMPERATURE CONTROLS/BACS

1. Part 1 – General

1.1 Related Documents

A. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section

B. All work of this Division shall be coordinated and provided by the single Building Automation and Controls System (BACS) Contractor.

C. The work of this Division shall be scheduled, coordinated, and interfaced with the associated work of other trades.

D. The work of this Division shall be as required by the Specifications, Point Schedules and Drawings.

E. If the BACS Contractor believes there are conflicts or missing information in the project documents, the Contractor shall promptly request clarification and instruction from the design team.

1.2 1.2. Summary of the Work

A. Temperature controllers furnished under the base contract shall control space conditions as described in Section 01 10 00 Summary of the Work and shall be products furnished and/or approved by the equipment manufacturers.

1. Temperature controllers located in public spaces shall have lockable tamper proof covers. Cover shall be commercial quality suitable for installation in finished areas.

B. Temperature controllers, occupancy controllers, and the building automation and control system (BACS) that are specified in Alternates 1, 2 and 3 shall control space conditions and energy usage as described on Section 01 10 00 Summary of the Work.

1. BACS shall be digital systems that are compatible to operate with the controllers and sensors in the equipment provided.

2. Temperature controllers located in public spaces shall have lockable tamper proof covers. Cover shall be commercial quality suitable for installation in finished areas.

1.3 BACS Description

A. The BACS shall be a complete system designed for use with the enterprise IT systems. This functionality shall extend into the equipment rooms. Devices residing on the automation network located in equipment rooms and similar shall be fully IT compatible devices that mount and communicate directly on the IT infrastructure in the facility. Contractor shall be responsible for coordination with the owner's IT staff to ensure that the BACS will perform in the owner's environment without disruption to any of the other activities taking place on that LAN.

The BACS shall utilize wireless sensor- and field-level communication as described in the following sections. Contractor shall be responsible for coordination with the owner's IT staff to ensure there will be no interference with other wireless communication taking place in the building (e.g. Wi-Fi).

B. All points of user interface shall be on standard PCs that do not require the purchase of any special software from the BACS manufacturer for use as a building operations terminal. The primary point of interface on these PCs will be a standard Web Browser.

C. The work of the single BACS Contractor shall be as defined individually and collectively in all Sections of this Division of the specifications together with the associated Point Sheets and Drawings and the associated interfacing work as referenced in the related documents.

D. Provide a complete, neat and workmanlike installation. Use only manufacturer employees who are skilled, experienced, trained, and familiar with the specific equipment, software, standards and configurations to be provided for this Project.

E. The BACS as provided shall incorporate, at minimum, the following integrated features, functions and services:

1. Operator information, alarm management and control functions.
2. Enterprise-level information and control access.
3. Information management including monitoring, transmission, archiving, retrieval, and reporting functions.
4. Diagnostic monitoring and reporting of BACS functions.
5. Offsite monitoring and management access.
6. Energy management
7. Standard applications for terminal HVAC systems.
8. Indoor Air Quality monitoring and control

1.4 Quality Assurance

A. General

1. The BACS Contractor shall be the primary manufacturer-owned branch office that is regularly engaged in the engineering, programming, installation and service of total integrated Building Management Systems.
2. The BACS Contractor shall be a recognized national manufacturer, installer and service provider of BACS.
3. The BACS Contractor shall have a branch facility within a 100-mile radius of the job site supplying complete maintenance and support services on a 24 hour, 7-day-a-week basis.
4. The BACS architecture shall consist of the products of a manufacturer regularly engaged in the production of Building Automation and Control Systems, and shall be the manufacturer's latest standard of design at the time of bid.

1.5 References

A. In the case of conflicts or discrepancies, the more stringent regulation shall apply.

1.6 Submittals

A. Shop Drawings, Product Data, and Samples

1. The BACS contractor shall submit a list of all shop drawings with submittals dates within 30 days of contract award.
2. The BACS Contractor shall correct any errors or omissions noted in the first review.
3. At a minimum, submit the following:
    a. BACS network architecture diagrams including all nodes and interconnections.
    b. Systems schematics, sequences and flow diagrams.
    c. Control Damper Schedule including a separate line for each damper provided under this section and a column for each of the damper attributes, including: Code Number, Fail Position, Damper Type, Damper Operator, Duct Size, Damper Size, Mounting, and Actuator Type.
    ~~d.~~ Room Schedule including a separate line for each VAV box and/or terminal unit indicating location and address
    e. Details of all BACS interfaces and connections to the work of other trades.
    f. Product data sheets or marked catalog pages including part number, photo and description for all products including software.

1.8 Record Documentation

A. Operation and Maintenance Manuals

1. Three (3) copies of the Operation and Maintenance Manuals shall be provided to the Owner's Representative upon completion of the project. The entire Operation and Maintenance Manual shall be furnished on Compact Disc media, and include the following for the BACS provided:
    a. Table of contents.
    b. As-built system record drawings. Computer Aided Drawings (CAD) record drawings shall represent the as-built condition of the system and incorporate all information supplied with the approved submittal.
    c. Manufacturer’s product data sheets or catalog pages for all products including software.
    d. System Operator’s manuals.
    e. Archive copy of all site-specific databases and sequences.
    f. BMS network diagrams.
    g. Interfaces to all third-party products and work by other trades.

1.9 Warranty

A. Standard Material and Labor Warranty:

1. Provide a (1) year labor and (3) year material warranty on the BACS.
2. If within twelve (12) months from the date of acceptance of product, upon written notice from the owner, it is found to be defective in operation, workmanship or

materials, it shall be replaced, repaired or adjusted at the option of the BACS Contractor at the cost of the BACS Contractor.

3. Maintain an adequate supply of materials within 100 miles of the Project site such that replacement of key parts and labor support, including programming. Warranty work shall be done during BACS Contractor's normal business hours.

2. Part 2 – Products

2.1 General Description

A. The BACS shall use an open architecture and fully support a multi-vendor environment. To accomplish this effectively, the BACS shall not be limited to a single open communication protocol standard, but to also integrate a wide variety of third-party devices and applications via additional protocols and through the latest software standards. The system shall be designed for use on the Internet, or intranets using off the shelf, industry standard technology compatible with other owner provided networks.

B. The BACS shall consist of the following:

1. Standalone Network Automation Engine(s)
2. DDC Controllers (HVAC etc.)
3. Local Display Devices
4. Operator Workstation

C. Acceptable Manufacturers

1) Johnson Controls, Metasys
2) Automated Logic – Harris Integrated Solutions

2.2 BACS Architecture

A. Automation Network

1. The automation network shall be based on a PC industry standard of Ethernet TCP/IP. Where used, LAN controller cards shall be standard "off the shelf" products available through normal PC vendor channels.
2. The BACS shall network multiple user interface clients, automation engines, system controllers and application-specific controllers. Provide application and data server(s) as required for systems operation.
3. The automation network shall be capable of operating at a communication speed of 100 Mbps, with full peer-to-peer network communication.

B. Control Network

1. Control networks shall provide either "Peer-to-Peer," Master-Slave, or Supervised Token Passing communications, and shall operate at a minimum communication speed of 9600 baud.
2. DDC Controllers shall reside on the control network.

3. The control network shall utilize ZigBee wireless mesh protocol for sensor- and field-level communication. The wireless network shall be capable of being integrated with any existing or future wired network with no loss of BMS integrity.

2.3 User Interface

A. Dedicated Web Based User Interface

1. The Owner shall provide and install a personal computer for command entry, information management, network alarm management, and database management functions. All real-time control functions, including scheduling, history collection and alarming, shall be resident in the BACS Network Automation Engines to facilitate greater fault tolerance and reliability.
2. Dedicated User Interface Architecture – The architecture of the computer shall be implemented to conform to industry standards, so that it can accommodate applications provided by the BACS Contractor and by other third party applications suppliers, including but not limited to Microsoft Office Applications. Specifically it must be implemented to conform to the following interface standards.
    a. Microsoft Internet Explorer for user interface functions
    b. Microsoft Office Professional for creation, modification and maintenance of reports, sequences other necessary building management functions
    c. Microsoft Outlook or other eMail program for supplemental alarm functionality and communication of system events, and reports
    d. Required network operating system for exchange of data and network functions such as printing of reports, trends and specific system summaries.
3. PC Hardware – The personal computer(s) shall be configured as follows:
    a. Memory – 512 MB (Minimum)
    b. CPU– Pentium 4 or greater; 2.8 MHz or Faster Clock Speed
    c. Hard Drive – 40 GB or greater hard drive
    d. Hard drive backup system – CD/RW, DVD/RW or network backup software provided by IT department
    e. CD ROM Drive – 32X performance
    f. Ports – (2) Serial and (1) parallel, (2) USB ports
    g. Keyboard – 101 Keyboard and 2 Button Mouse
    h. CRT configuration – 1-2 CRTs as follows:
        ◊ Each Display – 17” Flat Panel Monitor 1280 x 1024 resolution minimum
        ◊ Display card with multiple monitor support
    i. LAN communications – Ethernet communications board; 3Comm or equal.
4. Operating System Software
    a. Windows XP
    b. Where user interface is not provided via browser, provide complete operator workstation software package, including any hardware or software keys. Include the original installation disks and licenses for all included software, device drivers, and peripherals.

B. Distributed Web Based User Interface

1. All features and functions of the dedicated user interface previously defined in this document shall be available on any computer connected directly or via a wide area or virtual private network (WAN/VPN) to the automation network and conforming to the following specifications.
2. The software shall run on the Microsoft Internet Explorer (6.0 or higher) browser.

C. User Interface Application Components

1. Operator Interface
    a. An integrated browser based client application shall be used as the user operator interface program.
    b. All Inputs, Outputs, Set points, and all other parameters as defined within Part 3, shown on the design drawings, or required as part of the system software, shall be displayed for operator viewing and modification from the operator interface software.
    c. The user interface software shall provide help menus and instructions for each operation and/or application.
    d. The operation of the control system shall be independent of the user interface, which shall be used for operator communications only. Systems that rely on an operator workstation to provide supervisory control over controller execution of the sequences of operations or system communications shall not be acceptable.
2. Schedules
    a. A graphical display for time-of-day scheduling and override scheduling of building operations shall be provided. At a minimum, the following functions shall be provided:
        ◊ Weekly schedules
        ◊ Exception Schedules
        ◊ Monthly calendars.
    b. Changes to schedules made from the User Interface shall directly modify the Network Automation Engine schedule database.
3. Password
    a. Multiple-level password access protection shall be provided to allow the user/manager to user interface control, display, and database manipulation capabilities deemed appropriate for each user, Based on an assigned password.
4. Dynamic Color Graphics
    a. The graphics application program shall be supplied as an integral part of the User Interface. Browser or Workstation applications that rely only upon HTML pages shall not be acceptable.
    b. The graphics applications shall include a create/edit function and a runtime function. The system architecture shall support an unlimited number of graphics documents (graphic definition files) to be generated and executed. The graphics shall be able to display and provide animation based on real-time data that is acquired, derived, or entered.
    c. Operation from graphics – It shall be possible to change values (set points) and states in system controlled equipment by using drop-down windows
5. Historical trending and data collection

a. Each Automation Engine shall store trend and point history data for all analog and digital inputs and outputs, as follows:

◊ Any point, physical or calculated, may be designated for trending. Two methods of collection shall be allowed:

Defined time interval

Upon a change of value

6. Trend data viewing and analysis

a. Provide a trend viewing utility that shall have access to all database points.

b. It shall be possible to retrieve any historical database point for use in displays and reports by specifying the point name and associated trend name.

c. Trend studies shall be capable of calculating and displaying calculated variables including highest value, lowest value and time based accumulation.

2.4 Supervisory Controller

A. Supervisory Controller

1. The Network Automation Engine shall be a fully user-programmable, supervisory controller. The Automation Engine shall monitor the network of distributed application-specific controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Automation Engines.

2. Automation network – The Network Automation Engine (NAE) shall reside on the automation network.

3. User Interface – Each NAE shall have the ability to deliver a web based user interface as previously described. All computers connected physically or virtually to the automation network shall have access to the web based UI. Systems without such capability at this level shall provide a user interface via the combination of operator workstations and Web servers as determined by the owner for comparable operation.

4. Power Failure – In the event of the loss of normal power, The NAE shall continue to operate for a user adjustable period of up to 10 minutes after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software. Flash memory shall be incorporated for all critical controller configuration data.

a. During a loss of normal power, the control sequences shall go to the normal system shutdown conditions.

b. Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.

5. Certification – All controllers shall be listed by Underwriters Laboratories (UL).

2.5 Application Specific Controllers

A. Rooftop Unit and WSHP Controllers (AHU)

1. Each Air Handling Unit controller shall operate as a standalone controller capable of performing its specified control responsibilities independently of other

controllers in the network. Each AHU controller shall be a microprocessor-Based, multi-tasking, real-time digital control processor.

2. Each controller shall include an integral digital display to show all available points in the controller and be password protected.

B. VAV Modular Assembly (VMA)

1. The VAV Modular Assembly shall provide both standalone and networked direct digital control of pressure-independent, variable air volume terminal units.

2. The VAV Modular Assembly shall be a configurable digital controller with integral differential pressure transducer and damper actuator. All components shall be connected and mounted as a single assembly that can be removed as one piece.

2.6 Software Programming/Tools

A. Program Editor

1. Definition of operator device characteristics, DDC panels, individual points, applications, and control sequences shall be performed through the browser based user interface.

2. All temperature and equipment control strategies and energy management routines shall be definable by the operator. System definition and modification procedures shall not interfere with normal system operation and control.

3. The programming environment shall provide help menus and instructions for each operation and/or application performed, for all programming library functions, and for the programming language itself.

2.7 Input Devices

A. General Requirements

1. Installation, testing, and calibration of all sensors, transmitters, and other input devices shall be provided to meet the system requirements.

B. Temperature Sensors

1. General Requirements:

a. Sensors and transmitters shall be provided, as outlined in the input/output summary and sequence of operations.

b. The temperature sensor shall be of the resistance type, and shall be either two-wire 1000 ohm nickel RTD, or two-wire 1000 ohm platinum RTD.

c. The following point types (and the accuracy of each) are required, and their associated accuracy values include errors associated with the sensor, lead wire, and A to D conversion:

Point Type	**Accuracy**
Chilled Water	± .5°F.
Room Temp	± .5°F.
Duct Temperature	± .5°F.
All Others	± .75°F.

2. Room Temperature and Room Temperature/Humidity Sensors with Integral Occupancy Sensor
    a. Room sensors shall be constructed for either surface or wall box mounting.
    b. Room sensors shall have the following options when specified:
        ◊ Setpoint reset dial providing a ±3 degree (adjustable) range and digital display.
        ◊ A momentary override request push button for activation of after-hours operation.
    c. Room sensors shall capable of communicating wirelessly via the ZigBee protocol. Sensors shall utilize two (2) AA batteries and shall not require a dedicated 24 VDC power feed. Sensors shall have a minimum five (5) year battery life along with battery level indication reported through the BMS. Please reference Section 2.9.
3. Thermo wells
    a. When thermo wells are required, the sensor and well shall be supplied as a complete assembly, including wellhead and Greenfield fitting.
    b. Thermo wells and sensors shall be mounted in a threadolet or 1/2" NFT saddle and allow easy access to the sensor for repair or replacement.
4. Outside Air Sensors
    a. Outside air sensors shall be designed to withstand the environmental conditions to which they will be exposed. They shall also be provided with a solar shield.
    b. Temperature transmitters shall be of NEMA 3R construction and rated for ambient temperatures.
5. Duct Mount Sensors
    a. Duct mount sensors shall mount in an electrical box through a hole in the duct, and be positioned so as to be easily accessible for repair or replacement.
    b. Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.
6. Averaging Sensors
    a. For ductwork greater in any dimension that 48 inches and/or where air temperature stratification exists, an averaging sensor with multiple sensing points shall be used.

C. Humidity Sensors
1. The sensor shall be a solid-state type, relative humidity sensor of the Bulk Polymer Design. The sensor element shall resist service contamination.
2. The humidity transmitter shall be equipped with non-interactive span and zero adjustments, a 2-wire isolated loop powered, 4-20 mA, 0-100% linear proportional output.
3. The humidity transmitter shall meet the following overall accuracy, including lead loss and Analog to Digital conversion. 3% between 20% and 80% RH @ 77 Deg F unless specified elsewhere.
4. Duct type sensing probes shall be constructed of 304 stainless steel, and shall be equipped with a neoprene grommet, bushings, and a mounting bracket.

5. Acceptable Manufacturers: Johnson Controls, Veris Industries, Mamac or approved equal.

D. Differential Pressure Transmitters

1. General Air and Water Pressure Transmitter Requirements:
    a. Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage, and to hold calibrated accuracy when subject to a momentary 40% over-range input.
    b. Pressure transmitters shall transmit a 0 to 5 VDC, 0 to 10 VDC, or 4 to 20 mA output signal.
    c. Differential pressure transmitters used for flow measurement shall be sized to the flow sensing device, and shall be supplied with Tee fittings and shut-off valves in the high and low sensing pick-up lines to allow the balancing Contractor and Owner permanent, easy-to-use connection.
    d. A minimum of a NEMA 1 housing shall be provided for the transmitter. Transmitters shall be located in accessible local control panels wherever possible.
2. Building Differential Air Pressure Applications (-1" to +1" w.c.)
    a. The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points.
    b. The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:
        ◊ -1.00 to +1.00 w.c. input differential pressure ranges. (Select range appropriate for system application)
        ◊ 4-20 mA output.
        ◊ Maintain accuracy up to 20 to 1 ratio turndown.
        ◊ Reference Accuracy: +0.2% of full span.
    c. Acceptable Manufacturers: Johnson Controls and Setra.
3. Medium Differential Air Pressure Applications (5" to 21" w.c.)
    a. The pressure transmitter shall be similar to the Low Air Pressure Transmitter, except that the performance specifications are not as severe. Differential pressure transmitters shall be provided that meet the following performance requirements:
        ◊ Zero & span: (c/o F.S./Deg. F): .04% including linearity, hysteresis and repeatability.
        ◊ Accuracy: 1% F.S. (best straight line) Static Pressure Effect: 0.5% F.S. (to 100 PSIG.
        ◊ Thermal Effects: <+.033 F.S./Deg. F. over 40°F. to 100°F. (calibrated at 70°F.).
    b. Acceptable manufacturers: Johnson Controls, Setra or approved equal.

E. Status and Safety Switches

1. General Requirements
    a. Switches shall be provided to monitor equipment status, safety conditions, and generate alarms at the BACS when a failure or abnormal condition

occurs. Safety switches shall be provided with two sets of contacts and shall be interlock wired to shut down respective equipment.

2. Current Sensing Switches
    a. The current sensing switch shall be self-powered with solid-state circuitry and a dry contact output. It shall consist of a current transformer, a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay, and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over-current up to twice its trip point range.
    b. Current sensing switches shall be used for run status for fans, pumps, and other miscellaneous motor loads.
    c. Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.
    d. Acceptable manufacturers: Veris Industries or approved equal.

3. Air Filter Status Switches
    a. Differential pressure switches used to monitor air filter status shall be of the automatic reset type with SPDT contacts rated for 2 amps at 120VAC.
    b. A complete installation kit shall be provided, including: static pressure tops, tubing, fittings, and air filters.
    c. Provide appropriate scale range and differential adjustment for intended service.
    d. Acceptable manufacturers: Johnson Controls, Cleveland Controls or approved equal.

2.8 Output Devices

A. Actuators
    1. General Requirements
        a. Damper and valve actuators shall be electronic and/or pneumatic, as specified in the System Description section.

B. Control Dampers
    1. The BACS Contractor shall furnish all automatic dampers. All automatic dampers shall be sized for the application by the BACS Contractor or as specifically indicated on the Drawings and as required by existing conditions.
    2. All dampers used for throttling airflow shall be of the opposed blade type arranged for normally open or normally closed operation, as required. The damper is to be sized so that, when wide open, the pressure drop is a sufficient amount of its close-off pressure drop to shift the characteristic curve to near linear.
    3. All dampers used for two-position, open/close control shall be parallel blade type arranged for normally open or closed operation, as required.
    4. Damper frames and blades shall be constructed of either galvanized steel or aluminum. Maximum blade length in any section shall be 60”. Damper blades shall be 16-gauge minimum and shall not exceed eight (8) inches in width. Damper frames shall be 16-gauge minimum hat channel type with corner bracing. All damper bearings shall be made of reinforced nylon, stainless steel or oil-

impregnated bronze. Dampers shall be tight closing, low leakage type, with synthetic elastomer seals on the blade edges and flexible stainless steel side seals. Dampers of 48"x48" size shall not leak in excess of 8.0 cfm per square foot when closed against 4" w.g. static pressure when tested in accordance with AMCA Std. 500.

C. Control Relays

1. Control Pilot Relays
    a. Control pilot relays shall be of a modular plug-in design with retaining springs or clips.
    b. Mounting Bases shall be snap-mount.
    c. DPDT, 3PDT, or 4PDT relays shall be provided, as appropriate for application.
    d. Contacts shall be rated for 10 amps at 120VAC.
    e. Relays shall have an integral indicator light and check button.
    f. Acceptable manufacturers: Johnson Controls, Lectro or approved equal.

D. Control Valves

1. All automatic control valves shall be fully proportioning and provide near linear heat transfer control. The valves shall be quiet in operation and fail-safe open, closed, or in their last position. All valves shall operate in sequence with another valve when required by the sequence of operations. All control valves shall be sized by the control manufacturer, and shall be guaranteed to meet the heating and cooling loads, as specified. All control valves shall be suitable for the system flow conditions and close against the differential pressures involved. Body pressure rating and connection type (sweat, screwed, or flanged) shall conform to the pipe schedule elsewhere in this Specification.
2. Chilled water control valves shall be modulating plug, ball, and/or butterfly, as required by the specific application. Modulating water valves shall be sized per manufacturer's recommendations for the given application. In general, valves (2 or 3-way) serving **variable** flow air handling unit coils shall be sized for a pressure drop equal to the actual coil pressure drop, but no less than 5 PSI. Valves (3-way) serving **constant** flow air handling unit coils with secondary circuit pumps shall be sized for a pressure drop equal to 25% the actual coil pressure drop, but no less than 2 PSI. Mixing valves (3-way) serving secondary water circuits shall be sized for a pressure drop of no less than 5 PSI. Valves for terminal reheat coils shall be sized for a 2 PSIG pressure drop, but no more than a 5 PSI drop.
3. Ball valves shall be used for hot and chilled water applications, water terminal reheat coils, radiant panels, unit heaters, package air conditioning units, and fan coil units except those described hereinafter.
4. Acceptable manufacturers: Johnson Controls, or approved equal.

2.9 Wireless Devices

A. General Requirements

1. All wireless communication shall utilize the BACnet ZigBee mesh protocol.

B. Temperature and Temperature/Humidity Sensors

1. Sensors shall include capability to measure and transmit temperature, humidity and occupancy override in combination without the use of separate sensors.
2. Sensors shall utilize two (2) AA batteries and shall not require a dedicated 24 VDC power feed.
3. Sensors shall have digital display capability.
4. Sensors shall have a minimum five (5) year battery life along with battery level indication reported through the BMS.
5. Sensors shall have LED indication of diagnostic information for use in commissioning and troubleshooting.
6. Wireless cooler/freezer temperature sensors shall be provided for use in cooler/freezer temperature monitoring as necessary.

C. Wireless Routers and Repeaters

1. Addressable, flag-type routers and repeaters shall be used to receive and transmit wireless communication.
2. Routers shall be connected and powered via the SA bus controller port. Repeaters shall require a separate 24V power supply.

D. Wireless Coordinators

1. Coordinators shall serve as end-of-line wireless devices for up to thirty-five (35) wireless-enabled controllers. Coordinators shall hard-wired downstream into the building communication bus.

3. Part 3 – Performance / Execution

3.1 Bacs Specific Requirements

A. Graphic Displays

1. Provide a color graphic system flow diagram display for each system with all points as indicated on the point list. All terminal unit graphic displays shall be from a standard design library.
2. User shall access the various system schematics via a graphical penetration scheme and/or menu selection. .

B. Actuation / Control Type

1. Primary Equipment
   a. Controls shall be provided by equipment manufacturer as specified herein.
   b. All damper and valve actuation shall be electric.
2. Air Handling and Rooftop Equipment
   a. All air handers shall be controlled with a HVAC-DDC Controller
   b. All damper and valve actuation shall be electric.
3. Terminal Equipment:

a. Terminal Units (VAV, UV, etc.) shall have electric damper and valve actuation.
b. All Terminal Units shall be controlled with HVAC-DDC Controller)

3.2 Installation Practices

A. BACS

1. All conduit, wiring, accessories and wiring connections required for the installation of the Building Management System, as herein specified, shall be provided by the BACS Contractor unless specifically shown on the Electrical Drawings under Division 16 Electrical. All wiring shall comply with the requirements of applicable portions of Division 16 and all local and national electric codes, unless specified otherwise in this section.
2. All BACS wiring materials and installation methods shall comply with BACS manufacturer recommendations.
3. Class 2 Wiring
   a. Class 2 (24VAC or less) wiring shall be installed in conduit unless otherwise specified.
   b. Conduit is not required for Class 2 wiring in concealed accessible locations. Class 2 wiring not installed in conduit shall be supported every 5' from the building structure utilizing metal hangers designed for this application. Wiring shall be installed parallel to the building structural lines. All wiring shall be installed in accordance with local code requirements.
4. Class 2 signal wiring and 24VAC power can be run in the same conduit. Power wiring 120VAC and greater cannot share the same conduit with Class 2 signal wiring.
5. Provide for complete grounding of all applicable signal and communications cables, panels and equipment so as to ensure system integrity of operation. Ground cabling and conduit at the panel terminations. Avoid grounding loops.

B. BACS Line Voltage Power Source

1. 120-volt AC to control panels used for the Building Management System shall be provided by Division 16.
2. Circuits used for the BMS shall be dedicated to the BMS and shall not be used for any other purposes.
3. DDC terminal unit controllers may use AC power from motor power circuits.

C. BACS Raceway

1. All wiring shall be installed in conduit or raceway except as noted elsewhere in this specification. Minimum control wiring conduit size 1/2".
2. Where it is not possible to conceal raceways in finished locations, surface raceway (Wiremold) may be used as approved by the Architect.

D. Penetrations

1. Provide fire stopping for all penetrations used by dedicated BMS conduits and raceways.
2. All openings in fire proofed or fire stopped components shall be closed by using approved fire resistive sealant.
3. All wiring passing through penetrations, including walls shall be in conduit or enclosed raceway.

E. BACS Identification Standards

1. Node Identification. All nodes shall be identified by a permanent label fastened to the enclosure. Labels shall be suitable for the node location.

F. BACS Panel Installation

1. The BMS panels and cabinets shall be located as indicated at an elevation of not less than 2 feet from the bottom edge of the panel to the finished floor. Each cabinet shall be anchored per the manufacturer's recommendations.

G. Input Devices

1. All Input devices shall be installed per the manufacturer recommendation
2. Locate components of the BMS in accessible local control panels wherever possible.

H. HVAC Input Devices – Genera1

1. All Input devices shall be installed per the manufacturer recommendation
2. Locate components of the BACS in accessible local control panels wherever possible.
3. The mechanical contractor shall install all in-line devices such as temperature wells, pressure taps, airflow stations, etc.
4. Input Flow Measuring Devices shall be installed in strict compliance with ASME guidelines affecting non-standard approach conditions.
5. Outside Air Sensors
    a. Sensors shall be mounted on the North wall to minimize solar radiant heat impact or located in a continuous intake flow adequate to monitor outside air conditions accurately.
    b. Sensors shall be installed with a rain proof, perforated cover.
6. Building Differential Air Pressure Applications (-1" to +1" w.c.):
    a. Transmitters exterior sensing tip shall be installed with a shielded static air probe to reduce pressure fluctuations caused by wind.
    b. The interior tip shall be inconspicuous and located as shown on the drawings.
7. Air Flow Measuring Stations:
    a. Where the stations are installed in insulated ducts, the airflow passage of the station shall be the same size as the inside airflow dimension of the duct.
    b. Station flanges shall be two inch to three inch to facilitate matching connecting ductwork.
8. Duct Temperature Sensors:

a. Duct mount sensors shall mount in an electrical box through a hole in the duct and be positioned so as to be easily accessible for repair or replacement.

9. Space Sensors:
   a. Shall be mounted per ADA requirements.

I. HVAC Output Devices

1. All output devices shall be installed per the manufacturer's recommendation. The mechanical contractor shall install all in-line devices such as control valves, dampers, airflow stations, pressure wells, etc.
2. Actuators: All control actuators shall be sized capable of closing against the maximum system shut-off pressure. The actuator shall modulate in a smooth fashion through the entire stroke. When any pneumatic actuator is sequenced with another device, pilot positioners shall be installed to allow for proper sequencing.
3. Control Dampers: Shall be opposed blade for modulating control of airflow. Parallel blade dampers shall be installed for two position applications.
4. Control Valves: Shall be sized for proper flow control with equal percentage valve plugs. The maximum pressure drop for water applications shall be 5 PSI. The maximum pressure drop for steam applications shall be 7 PSI.
5. Electronic Signal Isolation Transducers: Whenever an analog output signal from the Building Management System is to be connected to an external control system as an input (such as a chiller control panel), or is to receive as an input a signal from a remote system, provide a signal isolation transducer. Signal isolation transducer shall provide ground plane isolation between systems. Signals shall provide optical isolation between systems

J. Wireless Installation

1. Prior to installation, wireless system functionality shall be ensured via field testing or floor plan analysis. When locating sensors, routers and repeaters, all signal-attenuating material shall be accounted and compensated for (e.g. metal, brick or concrete).
2. To ensure reliability, Contractor shall provide no fewer than two (2) downstream paths of communication per VAV or field controller. Wireless repeaters (requiring 24V power) shall be installed as needed to maintain wireless mesh integrity.
3. All wireless sensors (temperature and/or temperature plus humidity) shall be located as indicated on the drawings, but no greater than 50 ft. from the nearest wireless router.
4. All wireless routers shall be located on individual terminal or air-handling unit controllers as indicated on the drawings, but no greater than 50 ft. from the nearest wireless router or repeater.

5. Wireless coordinators shall be installed as end-of-line wireless devices no greater than 50 ft. from the nearest wireless router or repeater. Coordinators shall then be hard-wired into the building communication bus.

3.3 Training

A. The BACS contractor shall provide the following training services:

1. One day of on-site orientation by a system technician who is fully knowledgeable of the specific installation details of the project. This orientation shall, at a minimum, consist of a review of the project as-built drawings, the BACS software layout and naming conventions, and a walk through of the facility to identify panel and device locations.

3.4 **Commissioning**

A. Fully commission all aspects of the BACS work.

B. Acceptance Check Sheet

1. Prepare a check sheet that includes all points for all functions of the BMS as indicated on the point list included in this specification.

2. Submit the check sheet to the Engineer for approval

3. The Engineer will use the check sheet as the basis for acceptance with the BACS Contractor.

C. VAV box performance verification and documentation:

1. The BACS Contractor shall test each VAV box for operation and correct flow. At each step, after a settling time, box air flows and damper positions will be sampled. Following the tests, a pass/fail report indicating results shall be produced. Possible results are Pass, No change in flow between full open and full close, Reverse operation or Maximum flow not achieved. The report shall be submitted as documentation of the installation.

D. Promptly rectify all listed deficiencies and submit to the Engineer that this has been done.

3.5 Sequences

A. See Section 01 10 00 Summary of the Work, sub-paragraph 3.01 Scope of Work for the operating sequence of control.

END OF SECTION
23 09 00