

SECTION 23 09 00 – CONTROL SYSTEMS (UMKC)

1. GENERAL

1.1 RELATED DOCUMENTS

- A. The work of this Division shall be scheduled, coordinated, and interfaced with the associated work of other trades. Reference the Division 21, 22, 23 Sections for details.
- B. The work of this Division shall be as required by the Specifications, Point Schedules and Drawings.
- C. If the EMCS 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 DEFINITIONS

- A. Analog: A continuously variable system or value not having discrete levels. Typically exists within a defined range of limiting values.
- B. Binary: A two-state system where an “ON” condition is represented by one discrete signal level and an “OFF” condition is represented by a second discrete signal level.
- C. Building Automation & Control System (EMCS): The total integrated system of fully operational and functional elements, including equipment, software, programming, and associated materials, to be provided by this Division EMCS Contractor and to be interfaced to the associated work of other related trades.
- D. EMCS Contractor: The EMCS Contractor to provide the work of this Division. This Contractor

- I. Provide: The term "Provide" and its derivatives when used in this Division shall mean to furnish, install in place, connect, calibrate, test, commission, warrant, document and supply the associated required services ready for operation.
- J. Furnish: The term "Furnish" and its derivatives when used in this Division shall mean supply at the EMCS Contractor's cost to the designated third party trade contractor for installation. EMCS Contractor shall connect furnished items to the EMCS, calibrate, test, commission, warrant and document.
- K. Wiring: The term "Wiring" and its derivatives when used in this Division shall mean provide the EMCS wiring and terminations.
- L. Install: The term "Install" and its derivatives when used in this Division shall mean receive at the jobsite and mount.
- M. Owner: The term "Owner" shall refer to the University of Missouri.
- N. Protocol: The term "protocol" and its derivatives when used in this Division shall mean a defined set of rules and standards governing the on-line exchange of data between EMCS network nodes.
- O. Software: The term "software" and its derivatives when used in this Division shall mean all of programmed digital processor software, preprogrammed firmware and project specific digital process programming and database entries and definitions as generally understood in the EMCS industry for real-time, on-line, integrated EMCS configurations.
- P. University: The Term "University" shall mean the Curators of the University of Missouri, or any of its campuses individually.
- Q. The use of words in the singular in these Division documents shall not be considered as limiting when other indications in these documents denote that more than one such item is being referenced.
- R. Headings, paragraph numbers, titles, shading, bolding, underscores, clouds and other symbolic interpretation aids included in the Division documents are for general information on2 (nf)-1 Tw -3.1 la -3.1 ph num

- 14. DO - Digital Output
- 15. EEPROM - Electronically Erasable Programmable Read Only Memory
- 16. EMI - Electromagnetic Interference
- 17. FAS - Fire Alarm Detection and Annunciation System
- 18. GUI - Graphical User Interface
- 19. HOA - Hand-Off-Auto
- 20. ID - Identification
- 21. IEEE - Institute of Electrical and Electronics Engineers
- 22. I/O - Input/Output
- 23. LAN - Local Area Network
- 24. LCD - Liquid Crystal Display
- 25. LED - Light Emitting Diode
- 26. MCC - Motor Control Center
- 27. NC - Normally Closed
- 28. NIC - Not In Contract
- 29. NO - Normally Open
- 30. OWS - Operator Workstation
- 31. OAT - Outdoor Air Temperature
- 32. PC - Personal Computer
- 33. RAM - Random Access Memory
- 34. RF - Radio Frequency
- 35. RFI - Radio Frequency Interference
- 36. RH - Relative Humidity
- 37. ROM - Read Only Memory
- 38. RTD - Resistance Temperature Device
- 39. SPDT - Single Pole Double Throw

3. Terminal unit controls

1.4 EMCS DESCRIPTION

- A. Furnish all labor, materials, equipment, and service necessary for a complete and operating temperature control system, utilizing a high- speed, peer-to-peer network of Direct Digital Controls (DDC). For retrofit projects, the new controls shall replace all existing versions of the Honeywell Campus Building Automation system. Provide all control system hardware including, routers, repeaters, and electronic interfaces and actuation devices, as shown on the drawings and as described herein. Provide new work to be added to the campus operator workstations.
- B. Provide monitoring and control of chillers, boilers, packaged mechanical equipment, variable frequency drives, fuel oil systems,

Maintenance Manual shall be furnished on Compact Disc media, and include the following for the EMCS 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. Manufacturers product data sheets or catalog pages for all products including software.
- d. System Operator's manuals.
- e. Archive copy of all ~~113.033 202 2.03B 01w 2.263710 2.13110 (2) 2.4611w 2.02201 (3) 113.033~~

2.

2.1 MATERIALS

- A. All products used in this project installation shall be new and currently under manufacture.

2.2 COMMUNICATION

- A. General: The control system shall consist of a high-speed, peer-to-peer network of DDC controllers, a control system server, and a web-based operator interface.
- B. System software shall be based on a server/thin client architecture, designed around the open standards of web technology. The control system server shall be accessed

1.1 -) fo(0.0- jT) (using a web browser over the internet (see section 1.3 (see 6.4 (see 014 T1DC14e Tol) 120001e 36.51

b. Provide additional hardware (communication ports, video drivers, network interface cards, cabling, etc.) to facilitate all control functions and software requirements specified for the DDC system.

c. Minimum hardware configuration shall include the following:

- 1) Quad Core Processor
- 2) 4-24 GB RAM (size dependent on size of system)
- 3) 500 GB hard disk providing data at 3.0 Gb/sec (size dependent on historical data storage requirements)
- 4) Gigabit Ethernet Network adapter
- 5) 16x DVD+/-RW drive
- 6) Qwerty Ket20c /fPoa4 (age3ar)-6w(12)R(10)E(10)T(6)P(20)S(8)C(10)D(10)E(10)W(3)T(1)D(1)

- corresponding sequence of operation.
- d. Animation. Graphics shall be able to animate by displaying different image files for changed object status.
 - e. Alarm Indication. Indicate areas or equipment in an alarm condition using color or other visual indicator.
 - f. Manual. Points moved from automation and placed in the manual setting shall be graphically represented using a color change alerting users to the change in conditions.
 - g. Format. Graphics shall be saved in an industry-standard format such as BMP, JPEG, PNG, GIF, or SVG. Web-based system graphics shall be viewable on browsers compatible with World Wide Web Consortium browser standards. Web graphic format shall require no plug-in or shall only require widely available no-cost plug-ins.
7. Custom Graphics. Custom graphic files shall be created with the use of a graphics generation package furnished with the system. The graphics generation package shall be a graphically based system used to create and modify graphics that are saved in the same formats as are used for system graphics.
 8. Graphics Library. Furnish a complete library of standard HVAC equipment graphics such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators. This library also shall include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. The library shall be furnished in a file format compatible with the graphics generation package program.
- E. System Applications. System shall provide the following functionality to authorized operators as an integral part of the operator interface or as stand-alone software programs. If furnished as part of the interface, the tool shall be available from each workstation or web browser interface. If furnished as a stand-alone program, software shall be installable on a standard PC type personal computer with no limit on the number of copies that can be installed under the system license.
1. i . Automatic System Database Configuration. Each workstation (or web server) shall

- 9) CFM per Person, Average outside air flow per occupant
 - 10) % Time Above minimum, % of time outside air dampers are above the minimum when occupied (average of all)
21. Time Span Graphic Replay. Operator shall be able to “replay” any graphic in the system to see how key values changed over an operator-selected period of time. Operator shall be able to select the starting date/time for this display and the end date/time or the display

fully support the OpenADR 2.0a and 2.0b and does not require any additional specialized hardware.

27. BACnet Scheduling Interface (add-on). The BMS system shall allow third-party devices to read and write schedules via the BACnet protocol. These exposed schedules to third-party BACnet devices are used to control when mechanical equipment runs. Resolves schedule issues with products like SchoolDude® - Operations Management Software.
28. Trend Export (add-on). The BMS shall allow user to specify, manage, and export trend source data to a .CSV file. User can export the files on-demand at any time or at scheduled intervals allowing user to process or analyze trend data outside of the building automation system. Up to two years of trend data can be exported.
29. HVAC Schedule Optimization (add-on). The BMS shall gather information from a Lenel® OnGuard® badge reader data system to track historical occupancy trend and then predict future facility occupancy levels. The system then shall automatically adjust zone and building schedules, optimizing energy usage and operational efficiency. System shall analyze each day type separately to account for daily differences, e.g. Monday vs Friday departures. The OnGuard® version 7.0 or later if using DataConduIT interface or version 7.4 or later if using OpenAccess interface.

F. The Network Controller must provide the following hardware features as a minimum:

1. One Ethernet Port 100 Mbps or better, RJ45
2. Three independent BACnet® MS/TP Channels.
3. Battery Backup using Gold Capacitor to avoid low battery alarms and subsequent replacement during service life of the controller.
4. Flash memory for long term data backup (If battery backup or flash memory is not supplied, the controller must contain a hard disk with at least 1 gigabyte storage capacity)
5. A Reset Button
6. The NC must be capable of operation over a temperature range of 0 to 50°C
7. The NC must be capable of withstanding storage temperatures of between 5 and 70°C
8. The NC must be capable of operation over a humidity range of 5 to 93% RH, non-condensing
9. Shall include expansion for Input/Output
10. Field Bus for remote I/O

2.4 ADVANCED APPLICATION SPECIFIC CONTROLLERS (AASC)

1. All Advanced Application Controller shall be fully programmable and shall at all times maintain their BACnet® compliance. All control sequences within or programmed into the B-AAC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained. Every device in the system which executes control logic and directly controls HVAC equipment must conform to a standard BACnet Device profile as specified in ANSI/ASHRAE 135, BACnet Annex L. Unless otherwise specified, hardwired actuators and sensors may be used in lieu of communicating actuators, communicating sensors, BACnet Smart Actuators and BACnet Smart Sensors.
2. Stand-alone, Native BACnet®, UL Listed Application Controllers shall be used to provide direct digital control of HVAC equipment. In addition to their standalone capabilities, they shall also provide the ability networked in a peer-to-peer, BACnet® MS/TP field network to other MS/TP controllers, and VAV/SPC zone controllers. These controllers may be used to optimize the energy consumption by implementing various control strategies such as temperature setup/setback etc.
3. Standard features for all Advanced Application Controllers shall include:

- a. Should support BACnet® intrinsic alarm reporting
- b. Should support calendar objects for scheduling
- c. Flexibility to be used and connected to Network Controller to expand the I/O capacity of network controller
- d. BACnet® MS/TP LAN with configurable baud rate from 9600 to 76.8k baud

2.5 AUXILIARY CONTROL DEVICES

- A. Motorized Control Dampers (U002 Tw g5(a.-j250 Tw 4.084 0 Td()Tj-0.002 1 Tc -0.a)-8r(4)Tc T(c)3.2652Tc

8. rotation direction.

2) Globe Valve: Bel

2F maximum differential, and vented ABS plastic cover. Acceptable manufacturer: ALC-TB series or approved equal.

E. Temperature sensors:

1. Temperature sensors shall be resistance temperature detector (RTD) or thermistor, 20K ohm NTC type.
2. Duct sensors for critical control locations (ie. Mixed air, discharge air, coil air) shall be averaging sensors. Duct sensors for non-critical locations (ie. Return air) shall be rigid single-point. Averaging sensors shall be a minimum of 5 ft in length per 10 ft² of duct cross section. Acceptable manufacturer:
 - a. Averaging Duct sensor: ALC NSB-10K-A series or approved equal
 - b. Single Point Duct sensor: ALC NSB-10K-2-D series or approved equal
3. Immersion sensors shall be provided with a separable stainless steel or copper well. Pressure rating of well shall be consistent with the system pressure in which it is to be installed. T Dd. Ta.iiiie88 -1.157 Tw -31.991h Tw 405h(e8we(i)44 TwoTjs[(D)-14. 034 14 Tw -31.988 -1

3. Acceptable manufacturer: Senva or approved equal.
- I. Current switches:
 1. Current-operated switches shall be self-powered, solid-state with adjustable trip current.

O. Airflow measuring stations (electronic):

1. Airflow measuring devices of the vortex shedding type, capable of continuously monitoring the airflow volume of the duct served and electronically transmitting a signal linear to the airflow volume, shall be provided where indicated. Airflow measuring devices shall be of the insertion type, or built into airflow control valves, as required, with the capability of measuring velocity over the full range of 350 to 7000 FPM. Devices shall consist of multiple velocity sensors, supported on insertion probe bars. Tek-Air or approved equal
2. Individual airflow sensors shall be of rugged construction and shall not require special handling during installation. Sensors shall be mounted on support bars, as required to achieve an equal area traverse. Standard materials shall be aluminum bars with aluminum

- m. Built-in communications protocols BACnet
- n. Standard NEMA 1 enclosure, NEMA 4X available

2. Acceptable manufacturer: Dent meter or approved other.

R. Local control panels:

- 1. All indoor control cabinets shall be fully enclosed NEMA 1 construction with [hinged door], and removable sub-panels.
- 2. Wires shall be color-coded solid conductors neatly installed in plastic troughs and/or tie-wrapped. All wires shall terminate to panel terminal blocks. 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 and off power switch with over-current protection for control power sources to each local panel.
- 4. Contractor shall make best efforts to locate control panels on the same floor as the equipment which it is connected to.
- 5. All control panels shall be built in accordance with UL508A standards and be labeled with separate UL label numbers. Acceptable manufacturer: Hoffman, Eaton, Hubbel/Wiegman, or approved equal.

S. Fan and Pump Motor Control:

- 1. Where applicable motors shall be controlled by a variable frequency drive (VFD). There shall not be more than 2 motors controlled by a single VFD.
- 2. VFD shall have a digital control panel and have an electronic by-pass. In applications where there is no back-up or redundant device the VFD shall be equipped with a Manual By-Pass.
- 3. VFD shall be capable of BACnet integration.
- 4. Acceptable manufacturers: Eaton (Cutler Hammer), Toshiba or an approved equal.

2.6 WIRING AND RACEWAYS

- A. General: Provide copper wiring, plenum cable, and raceways as specified in the applicable sections of Division 26.
- B. All

3.2 EXAMINATION

- A. The project plans shall be thoroughly examined for control device and equipment locations. Any

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

- K. Install insulated bushings on all raceway ends and openings to enclosures. Seal top end of all vertical raceways.
- L. The Contractor shall terminate all control and interlock wiring and shall maintain updated wiring diagrams with terminations identified at the job site.

3.8 INSTALLATION OF SENSORS

- A. Install sensors in accordance with the manufacturer's recommendations.
 - 1. Sensor locations are to be noted on graphics (ie. Duct pressure sensors, CO2 sensors, building pressure sensors, etc.).
 - 2. Mount sensors rigidly and adequately for the environment within which the sensor operates.

3.9 CONTROL SYSTEM CHECKOUT AND TESTING

- A. Startup testing: All testing listed in this Article shall be performed by the Contractor and shall make up part of the necessary verification. Tw -17.108 -1.157 8gn(ng)-12(CO)-4.1o.1 (es)-8 (gn(ng).2 (e)-12e s)-8.1