SECTION 23 09 23 – DIRECT-DIGITAL CONTROL SYSTEM FOR FONTANA UNIFIED SCHOOL DISTRICT

PART 1 - GENERAL

1.1 SUMMARY

A. The Direct-Digital Control (DDC) System specified herein shall include materials, operator workstation, building controllers, sensors, control valves, wiring, installation, start-up, testing, documentation and training for a complete operable system as required for this project.

B. Controls Engineering shall be provided by the local controls manufacturer representative.

C. Work specified under this section shall be performed by, or under the direct supervision of the local controls manufacturer representative, or by a contractor that is certified by the controls manufacture to perform all work within Section 23 09 00 Instrumentation and Control for HVAC and those sections of 23 09 00 that have been specified herein.

D. Alternate techniques, modifications or changes to any aspect of these specifications may be submitted as a voluntary alternate no later than (15) days prior to the bid date and with sufficient information for a complete evaluation. This information shall include product data sheets, a UL508A Standard for Industrial Control Panels statement of compliance for any locally manufactured control panels, a detailed sequence of operation and engineered shop drawing. Shop drawings shall include the following as a minimum. Point to point wiring diagrams for each piece of equipment to be controlled, a network riser diagram that will depict quantity and location of the operator workstation, controllers, routers and repeaters required for this project.

1.2 RELATED SECTIONS

A. 01 00 00: General Requirements

B. 01 33 00: Submittal Procedures

C. 23 00 00: Heating, Ventilating, and Air Conditioning (HVAC)

D. 23 08 00: Commissioning of HVAC

E. 26 00 00: Electrical

1.3 SUBMITTALS

A. Submit engineered shop drawings, sequences of operation, third party equipment and controls integration points, graphics examples to include floor plans and all pieces of equipment being controlled and product data sheets covering all items of equipment for the proposed system prior to installation for approval. Any deviation from the contract documents shall be noted and the drawings signed and dated by the Contractor. Additionally, submit a UL508A Standard for Industrial Control Panels statement of compliance for any locally manufactured control panels.

B. After completion of the installation and commissioning, a full set of as-built documentation shall be turned over to the Owner. The as-built shall include operation and maintenance manuals, sequence of operation, shop drawings and digital copies of the following.

1. Complete DDC System database backup

2. Source files for all custom written controller applications

3. Source files for graphics if required for this project

1.4 WARRANTY

A. Components, system software, and parts shall be guaranteed against defects in materials, fabrication, and execution for (1) year from date of system acceptance. Provide labor and materials to repair, reprogram, or replace components at no charge to the Owner during the warranty period.

B. Provide a list of applicable warranties for components, this list shall include warranty information, names, addresses, telephone numbers, and procedures for filing a claim and obtaining warranty services.

C. Respond to the Owner's request for warranty service within (24) hours during normal business hours. Submit records of the nature of the call, the work performed, and the parts replaced or service rendered.

D. Contractor shall request VPN access from owner and provide remote maintenance, software updates and repair service for the duration of the warranty period.

1.5 TRAINING

A. Provide a competent instructor who is factory trained and has comprehensive knowledge of system components and operations to provide full instructions to designated personnel in the system operation, maintenance, and programming. Training shall be specifically oriented to installed equipment and systems.

B. Provide (8) hours of onsite owner familiarization and training for the installed system. Training shall include system overview, time schedules, emergency operation, and programming and report generation.

C. Owner employees attending this training session shall be provided with the following documentation:

1. System layout point to point connection diagram.
2. System components cut sheets.
3. Operations and maintenance data.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Do not store or install electronic hardware on the project until non-condensing environmental conditions have been established.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. DDC Equipment: Carrier OPEN BACnet Controls. No substitutions will be accepted.

B. Controls installation will be by Russel Sigler Inc. No Exceptions

C. Indoor Air Quality Devices: Senva Inc.

2.2 SYSTEM LISTING COMPLIANCE

A. Locally manufactured control panels shall meet all requirements as outlined by UL 508A standard and shall be both approved and listed by Underwriters Laboratories, Inc.

2.3 COMMUNICATION

A. Controller and operator interface communication shall conform to ANSI/ASHRAE Standard 135, BACnet.

B. Each controller shall have a communication port for temporary connection to a laptop computer or other operator interface. Connection shall support memory downloads and other commissioning and troubleshooting operations.

C. Use owner provided Ethernet backbone for network segments.

2.4 OPERATOR INTERFACE

A. Description. The control system shall be as shown and consist of a high-speed, peer-to-peer network of DDC controllers and a stand-alone web server operator interface. Depict each mechanical system and building floor plan by a point-and-click graphic. A web server shall gather data from this system and generate web pages accessible through a conventional web browser on each PC connected to the network. Operators with sufficient access level shall have an ability to make changes to all system and equipment graphics in the web server in addition to having full DDC system access to make configuration changes to the control system. Any tools required for making graphic changes shall be provided with web server.

B. Operator Interface. Upgrade (1) Existing i-Vu Pro Web server interface as shown on the system drawings.

1. With the use of an owner provided remote SMTP email server the operators interface web server shall notify personnel of an alarm and record information about an alarm in the DDC system.

2. Any required installation or commissioning software shall be provided to the owner.

C. Operator Functions. Operator interface shall allow each authorized operator to execute the following functions as a minimum:

1. Log In and Log Out
2. Point-and-click Navigation
3. View and Adjust Equipment Properties
4. View and Adjust Operating Schedules
5. View and Respond to Alarms
6. View and Configure Trends
7. Manage Control System Hardware
8. Manage Operator Access

D. System Graphics. Operator interface shall be graphical and shall include at least one graphic per piece of equipment and graphics that summarize conditions on each floor of each building included in this contract. Indicate thermal comfort on floor plan summary graphics using dynamic colors to represent zone temperature relative to zone setpoint.

E. Trend Configuration. Operator shall be able to configure trend sample or change of value

(COV) interval, start time, and stop time for each system data object and shall be able to

retrieve data for use in spreadsheets and standard database programs

F. Reports and Logs. Operator shall be able to select, to modify, to create, and to print reports and logs. Furnish the following standard system reports.

1. Alarm Reports
2. Schedule Reports
3. Security Reports
4. Commissioning Reports
5. Equipment Reports

G. Energy Conservation

1. Outside Air Lockout. Lock out heating or cooling modes based on configurable outside air temperature limits.

2. Demand Limiting

a. System shall monitor building power consumption from building power meter pulse generator signals or from building feeder line watt transducer or current transformer.

b. The system shall include all required hardware and software necessary to receive an Automated Demand Response (ADR) signal from the utilities Demand Response Automation Server (DRAS).

c. When power consumption exceeds adjustable levels, or the system receives an ADR signal from the utility, the system shall automatically adjust set points, and take other programmatic actions to reduce demand.

3. Optimal Start. The system shall bring the conditioned space to within occupied set points prior to the occupied time period to ensure occupant comfort.

4. Demand Controlled Ventilation (DCV). Each controlled space shall have a Carbon Dioxide (CO2) sensor and shall maintain a ventilation setpoint through a DCV algorithm to fulfill the requirements of ASHRAE standard, 62-1989 “Ventilation for Acceptable Indoor Air Quality” (including Addendum 62a-1990).

2.5 CONTROLLERS

A. General. The control system shall be available as a complete package with the required input sensors and devices readily available. Provide BACnet Building Controllers (BC), Advanced Application Controllers (AAC), Application Specific Controllers (ASC), and Sensors (SEN) as required.

B. Stand-Alone Operation. Each piece of equipment shall be controlled by a single controller to provide stand-alone control in the event of communication failure.

C. Serviceability. Controllers shall have diagnostic LEDs for power, communication, and processor.

D. Rooftop Unit Controller (RTC). Defined as Application Specific Controllers (ASC), shall be factory installed by the HVAC manufacturer and shall control all associated HVAC rooftop equipment functions in a single zone application or as part of a zoning system application.

1. Capacity control shall be based by the RTC internal time clock and setpoints (cooling and heating) coupled with a communicating room sensor. The controls shall provide separate occupied and unoccupied cooling and heating setpoints.

2. RTC shall utilize up to 2 speed of fan control, up to 3 stages of cooling, and up to 4 stages of heating.

3. RTC shall provide economizer control that has been certified for Fault Detection and Diagnostics (FDD) by California Energy Commission (CEC). The FDD system shall detect the following faults:
   a. Air temperature sensor failure/fault
   b. Not economizing when it should
   c. Economizing when it should not
   d. Damper not modulating
   e. Excess outdoor air

E. Zone Controller (ZC). Defined as Application Specific Controllers (ASC) shall be capable of independent zone control or function as part of the zoning system.

1. ZC shall have an integrated brushless actuator, onboard pressure sensor and shall perform pressure independent zone control by measuring and controlling CFM being delivered to the zone.

2. The ZC shall utilize the Dual Maximum Control Setpoints VAV Box Logic as defined by Title 24.

F. Bypass Controller (BC). Defined as Application Specific Controllers (ASC) shall be capable of reading supply static pressure and controlling the bypass damper (or a VFD speed control output) to maintain the supply static set point in the supply duct. This operation shall be provided when operating within a zoning system application, or in a stand-alone mode.

1. BC shall have an integrated brushless actuator and onboard pressure sensor to measure and control duct static pressure.

G. General Purpose Controller. Defined as Advanced Application Controller (AAC) shall be a solid state micro-controller with pre-tested and factory configured software designed for controlling building equipment using DDC algorithms and facility management routines. The controller shall be capable of operating in either a stand-alone mode or as part of a network.

2.6 FIELD INSTALLED SENSORS

A. Space Temperature Sensors shall communicate to the controller over a 4-wire communication network and have setpoint adjustment, after hours override, occupancy sensor, LCD display and a communication service port.

B. Carbon dioxide sensor (CO_2) shall be integrated into the Space Temperature Sensors and have integral programming to perform automatic baseline calibration without user interface. The recommended manual recalibration period shall not be less than five years.

C. Outside Temperature Sensors shall be 10K Type 2, at least one sensor per building shall be provided to be shared via the network to all equipment within the corresponding building.

D. Status indication for fans or pumps shall be provided by current sensing switch. The sensor shall be installed at the motor starter or motor to provide load indication. The unit shall consist of a current transformer, a solid state current sensing circuit (with adjustable set point) and a solid state switch. A light emitting diode (LED) shall indicate the on off status

of the unit.

E. TotalSense Series - Indoor Environmental and Air Quality Sensor

1. The sensor shall be an indoor air quality sensor that has the option to sense all the following: CO2, Humidity, Temperature, Particulate Matter, TVOCs, Ambient light, Occupancy, and Barometric Pressure.
2. The sensor shall meet CE and RoHS requirements.
3. The sensor shall be able to communicate both digitally with Modbus and BACnet and with analog outputs.
4. The device shall communicate using BACnet MS/TP or Modbus RTU at speeds of 9600 to 115200 using a 3 wire RS-485 with isolated ground connection.
5. The sensor shall be powered by 24VAC and 24-30VDC with a nominal power consumption of 3.5W.
6. The sensor shall be able to output both 0-5V/0-10V and 3 wire 4-20mA that are +/- 1% accurate to what is displayed on the device.
7. The sensor shall meet the following sensing requirements:

    a. CO2
        i. Type: Non-dispersive Infrared (NDIR)
        ii. Accuracy: ±(30ppm + 3% of reading) (400-2000ppm), -10-50ºC, 0-85%RH±(50ppm+ 5% of reading) (2000-5000ppm), -10-50ºC, 0-85%RH>5000ppm consult factory>5000ppm consult factory
        iii. Resolution: 1 ppm
        iv. Range: 0-10000ppm
        v. Response time: 90 seconds to 90% reading
        vi. Sample rate: 1s
        vii. Temp and Pressure Compensation: Yes, barometric pressure readable over comms

    b. Humidity
        i. Type: Digital CMOS
        ii. Accuracy: 2% models, +/-6% over 10 to 80%RH range
        iii. Resolution: 0.05%RH
        iv. Response time: 30s) Time for reaching 63% of reading at 25° C and 1 m/s airflow)
        v. Sample rate: 3s
        vi. Operating range: 0 to 100%RH (non-condensing)
        vii. Operating conditions: -4 to 140°F (-20 to 60° C) @ RH>90%; -4 to 176oF @ RH=50%

    c. TVOC
        i. Type: MOS
        ii. Gas: Total VOC

iii. Range: 0-10000 µg/m3
iv. Response Time: <10s
v. Temp and Pressure Compensation: Yes
vi. Output: 0-2000 µg/m3 (default) programmable up to 10000 µg/m3

d. PMx
i. Type: Optical
ii. Size Range: PM1.0, PM2.5, PM4.0, PM10.0
iii. Scale: 0-1000 µg/m3
iv. Lower detection limit: 0.3 µm
v. Precision: ±10 µg/m3 (0-100µg/m3); ±10% (100-1000 µg/m3)
vi. Long-Term Drift: ±1.25 µg/m3 / year

e. PIR (occupancy)
i. Type Passive: Infrared
ii. Axis X field of view: 140°, 15 ft (4.5m)
iii. Axis Y field of view: 76°, 15 ft (4.5m)

f. Ambient Light
i. Type: Phototransistor
ii. Scale: 0-100 fc (lm/ft2), readable over comms

g. Temperature Transmitter:
i. Type: Silicon Band-gap
ii. Nominal Accuracy: ±0.3° C (operating range)
iii. Maximum Accuracy: ±0.5° C (at 25° C), ±1.0° C
iv. Resolution: 0.1° C
v. Response time: 30s
vi. Sample rate: 3s

8. The sensor shall offer a secondary RTD/Thermistor temperature option.
9. The sensor shall operate from 0 to 50C
10. The sensor shall operate in a humidity range from 0-95% non-condensing
11. The sensor shall have an option relay with selectable NO/NC operation that can be used for, CO2 setpoint, RH setpoint, Temp setpoint, TVOC setpoint, PIR motion detection, Air Quality.
12. The sensor shall have an optional setpoint resistive slider.
13. The sensor shall have an optional override push button.
14. The sensor shall have wiring terminals to accommodate 14-26AWG wire.
15. The sensor electronics shall have a 7-year warranty.
16. The sensor shall have a 2-year warranty on all replaceable elements. (3 Year Warranty on replaceable CO2 Sensor Element)

F. TotalSense Series - Outdoor Environmental and Air Quality Sensor

1. The sensor shall be an Outdoor air quality sensor that has the option to sense all the following: CO2, Humidity, Temperature, Particulate Matter, TVOCs, and Barometric Pressure.
2. The sensor shall meet CE and RoHS requirements.
3. The sensor shall be able to communicate both digitally with Modbus and BACnet and with analog outputs.
4. The device shall communicate using BACnet MS/TP or Modbus RTU at speeds of 9600 to 115200 (switch selectable) using a 3 wire RS-485 with isolated ground connection. Address range 0-127
5. The sensor shall be powered by 24VAC and 24-30VDC with a nominal power consumption of 3.5W.
6. The sensor shall be able to output both 0-5V/0-10V and 3 wire 4-20mA that are +/- 1% accurate to what is displayed on the device.
7. The sensor shall meet the following sensing requirements:

    a. CO2
        i. Type: Non-dispersive Infrared (NDIR)
        ii. Accuracy: ±(30ppm + 3% of reading) (400-2000ppm), -10-50ºC, 0 85%RH±(50ppm+ 5% of reading) (2000-5000ppm), -10-50ºC, 0-85%RH>5000ppm consult factory>5000ppm consult factory
        iii. Resolution: 1 ppm
        iv. Range: 0-10000ppm
        v. Response time: 90 seconds to 90% reading
        vi. Sample rate: 1s
        vii. Temp and Pressure Compensation: Yes, barometric pressure readable over comms
    b. Humidity
        i. Type: Digital CMOS
        ii. Accuracy: 2% models, +/-6% over 10 to 80%RH range
        iii. Resolution: 0.05%RH
        iv. Response time: 30s) Time for reaching 63% of reading at 25° C and 1 m/s airflow)
        v. Sample rate: 3s
        vi. Operating range: 0 to 100%RH (non-condensing)
        vii. Operating conditions: -4 to 140°F (-20 to 60° C) @ RH>90%; -4 to 176oF @ RH=50%
    c. TVOC
        i. Type: MOS
        ii. Gas: Total VOC
        iii. Range: 0-10000 µg/m3
        iv. Response Time: <10s

v. Temp and Pressure Compensation: Yes

vi. Output: 0-2000 µg/m3 (default) programmable up to 10000 µg/m3

d. PMx

i. Type: Optical

ii. Size Range: PM1.0, PM2.5, PM4.0, PM10.0

iii. Scale: 0-1000 µg/m3

iv. Lower detection limit: 0.3 µm

v. Precision: ±10 µg/m3 (0-100µg/m3); ±10% (100-1000 µg/m3)

vi. Long-Term Drift: ±1.25 µg/m3 / year

e. Temperature Transmitter:

i. Type: Silicon Band-gap

ii. Nominal Accuracy: ±0.3° C (operating range)

iii. Maximum Accuracy: ±0.5° C (at 25° C), ±1.0° C

iv. Resolution: 0.1° C

v. Response time: 30s

vi. Sample rate: 3s

8. The sensor shall offer a secondary RTD/Thermistor temperature option.
9. The sensor shall operate from 0 to 50C
10. The sensor shall operate in a humidity range from 0-95% non-condensing
11. The sensor shall have an option relay with selectable NO/NC operation that can be used for, CO2 setpoint, RH setpoint, Temp setpoint, TVOC setpoint, PIR motion detection, Air Quality.
12. The sensor shall have an optional setpoint resistive slider.
13. The sensor shall have an optional override push button.
14. The sensor shall have wiring terminals to accommodate 14-26AWG wire.
15. The sensor electronics shall have a 7-year warranty.
16. The sensor operating range will be -4 to 122F.
17. The sensor shall have a 2-year warranty on all replaceable elements. (3 years on replaceable CO2 sensor element)

2.7 CONTROL PANELS

A. Provide single-door, hinged and gasketed UL 508A Listed; NEMA 12 or 4 to match environmental conditions, wall-mount enclosures for each system under automatic control. Mount relays, switches, and controllers in cabinet and indicators, pilot lights, push buttons and switches flush on enclosure exterior face as required.

B. Fabricate panels from 16 gauge steel with ANSI 61 gray finish and shall include (1) black padlock handle that will accommodate a padlock with up to a 5/16-in. locking bar for secure access to the enclosure contents. All additional latches shall be black non-locking handle type.

C. Provide three-layer phenolic, black outer layer with white core, engraved name plates that identify each control panel and for each component mounted to the exterior of the enclosure. Text shall be ½" minimum height, label should include Unique equipment ID and space served.

D. Provide a complete wiring diagram, bill of material for all components and markings with the following information:

1. Manufacturer's name or trademark

2. Supply voltage, number of phases, frequency, and full-load current for each incoming supply circuit

3. Enclosure type number

PART 3 - EXECUTION

3.1 ELECTRICAL WIRING

A. This contractor is responsible for all low voltage electrical installation and wiring for a fully operational DDC System as shown on the drawings and shall perform electrical installation in accordance with local and national electrical codes and in accordance with Division 26.

B. Install all HVAC control wiring, 24vdc or less, in anodized orange electrical metallic tubing (EMT) in exposed areas. Conduits in walls are to be reused. Plenum wire may be used in ceilings where anchored support is provided every 10 feet.

C. Electrical Contractor is responsible for providing power from local electrical panels to the DDC System control panels.

3.2 ACCEPTANCE PROCEDURE

A. Upon completion of the installation, the contractor shall start-up the system and perform all necessary calibration and testing to ensure the proper operation of the DDC System.

B. After all calibration and testing have been completed, the contractor shall schedule a hardware demonstration and system acceptance test to be performed in the presence of the designated owner's representatives.

END OF SECTION