



PBK Architects Florida, Inc. | West Palm Beach | 2047 Vista Parkway, West Palm Beach, Florida 33411

MURRAY MIDDLE SCHOOL MODERNIZATION

Martin County School District

PROJECT NUMBER: 25064.00

4400 SE MURRAY STREET, STUART, FL 34997

100% CONSTRUCTION DOCUMENTS – 2026/05/25

ADDENDUM #1, REVISION #1 – 2026/06/17



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SECTION 23 09 00 - HVAC INSTRUMENTATION AND CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.
- B. Refer to Division 1 for all requirements pertaining to General Provisions.

1.2 WORK INCLUDED

- A. Provide all required devices to tie into the existing EMS system to integrate into the system.
- B. Complete system of control and interlock wiring including wiring specified in Section 23 05 18, "Control Wiring" and Section 23 09 93, "Sequence of Operation".
- C. Interface with Product Integrated Controls specified in other sections of the specifications.
- D. This section also includes Web Based Open Protocol DDC building network controllers and Equipment controllers that are open protocol utilizing BACnet protocol for the purpose of controlling HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory wired controls, lighting in new and existing facilities.
- E. Access to the controls shall be through an owner provided IP address with use of a user ID and password. Contractor to provide a web server as part of the contract.

1.3 QUALITY ASSURANCE

- A. The installation of the building control system devices shall be by the manufacturer of the controls or his local authorized agent who has a minimum of 5 years of representation.
- B. All electrical components 25 V and above shall be U.L. listed or labeled.
- C. All equipment or piping used in the conditioned air stream, spaces or return air plenums shall comply with NFPA 90A Flame/Smoke/Fuel contribution rating of 25/50/0 and all applicable local building codes or requirements.
- D. All wiring shall conform to the National Electrical Code (NEC).
- E. All smoke dampers shall be rated in accordance with UL 555S.

1.4 DEFINITIONS

- A. Control Wiring: All wiring, 120 VAC or low voltage other than power wiring, required for the proper operation of the mechanical system.
- B. Power Wiring: All line voltage wiring to the mechanical equipment. Note: Where line voltage serves a control circuit such as power to a transformer, power to a DDC control panel, power for a line voltage thermostat, or damper this shall be considered control wiring.

1.5 SUBMITTALS

- A. Submit in accordance with Division 1 Requirements.
- B. Provide complete catalog data and installation instructions for each control component. Include damper and valve sizing details.
- C. Control system submittal shall contain the following graphics and documentation for each system being controlled:
 - 1. Communications bus schematic showing all panel locations and hardware requirements.
 - 2. Schematic wiring diagrams in ladder form for each system including power source.
 - 3. Schematic diagram with detail of all hardware, components used, location of instruments, bulbs, dampers, valves, and other components. The chart shall include control chart including control symbols, quantity, manufacturer's part number, tech sheet reference (include in submittal) and description of part.

4. Each DDC field panel shall be detailed in the submittal to identify termination boards within each panel and terminal of their respective field points. Each termination point shall define the point name and point description by each terminal with the field panel. Point names and descriptors shall be consistent throughout the submittal on the schematics, wiring diagrams, equipment list, etc.
 5. Submit the system architecture or configuration complete with all processors, terminals, other peripheral devices, modems, etc., with interconnecting diagrams.
 6. A report shall be included in the submittal to include every point in the entire system. The report shall include the programmed data for each point:
 - a. Point Name
 - b. Point Type (analog, digital, etc.)
 - c. Point Descriptor
 - d. Physical Address (enclosed legend)
 - e. Alarm (yes or no)
 - f. Print Alarm (yes or no)
 - g. High Limit
 - h. Low Limit
 - i. Totalized (yes or no)
 - j. Hours or Minutes Totalized
 - k. Engineering Unit of Point
 7. A flow chart form of sequence of operation in abbreviated English language.
 8. English language sequence of operation defining flow chart with control company programmed inputs to reflect English language sequence. Each sequence task shall be followed by the control company coded program. One list of coded programmed inputs at the end of each sequence of operation shall be acceptable.
- D. For each Direct Digital Control (DDC) panel provide:
1. Point List identifying each input and output by point name, point type, hardware description, wiring terminations, mounting arrangements and software features.
 2. Complete English language description of all software.
 3. Flow diagram and complete details program.

1.6 CONTROL SYSTEM GENERAL REQUIREMENTS

- A. The control system shall be of the electronic microprocessor type employing Direct Digital Control (DDC) Open Protocol technology (BACnet) technology for all control sequences unless specifically stated otherwise in the Sequence of Operation portion of this specification.
- B. All DDC controllers shall be connected via a communications bus to an operator's panel. The operator's panel may be located on the face of one of the DDC controllers, or at an alternate location as approved by the Engineers. In addition, a portable operator's panel may be connected to the system at any DDC controller location.
- C. All DDC controllers shall be connected to a global information handler, which shall send and receive information of the existing global nature throughout the system.
- D. Provisions shall be made to allow additional DDC controllers to be added at any point on the communications bus for future expansion.
- E. Field Installed Devices (FID) shall be capable of stand-alone operation, as well as interfacing with the networked Building Control System. These controllers shall be based on BACnet Protocols. No other protocols for this section will be acceptable.

- F. Valve and damper operators shall be of the electronic type.
- G. The existing Building Control System is made up of HVAC equipment with factory installed microprocessor-based Product Integrated Controls (PIC), distributed microprocessor-based Field Installed Devices (FID), input/output modules and necessary software set up for expansion under the original.
- H. The Product Integrated Controls (PIC) shall be factory installed controls capable of stand-alone operation. The controller shall be specifically designed to operate and monitor the functions of the HVAC equipment on which it is installed. The PIC shall be capable of interfacing onto the network.

1.7 INTENT OF DRAWINGS AND SPECIFICATIONS

- A. The implied and stated intent of the drawings and specifications is to establish minimum acceptable quality standards for materials, equipment, and workmanship and to provide a tie into the existing building control system. The ultimate goal of the MCSD for this campus and project is to have a fully integrated BACnet EMS system.
- B. The drawings are diagrammatic intending to show a workable general arrangement and location of system components and are not necessarily complete or rigid in all details.
- C. No deviation in the specified sequence of operation, as specified on drawings, will be allowed without written approval from the Engineer.

1.8 OPERATION AND MAINTENANCE MANUALS AND INSTRUCTIONS FOR OWNER

- A. Operation and maintenance manuals shall be provided as outlined in Division 1 Requirements. The manuals shall include all data which was a part of the original submittal with as-built wiring diagrams, parts lists and operating and maintenance instruction manuals.
- B. Refer to training hours table and scope in section 23 05 00 for job owner training conducted by a technician or technicians fully qualified to conduct such training shall be provided. Instruction or Training shall include, but not be limited to:
 - 1. Instructions in the manufacturers recommended maintenance and operating procedures.
 - 2. Instructions in the detailed sequence of operation of the mechanical equipment controls.
 - 3. Instructions in reading and using the control wiring diagrams.
 - 4. Instructions in control setpoint adjustment as relating to each specific system provided under this section.
 - 5. Performance testing as described in Part 3.

1.9 COOPERATION WITH OTHER CONTRACTORS

- A. The Building Control Sub-Contractor shall coordinate with other trades to assure a complete and operational Building Control System.
- B. This contractor shall furnish to the air balance contractor (Section 23 05 93) a notebook PC computer for terminal box set-up. At the completion of the balancing, the terminal shall be turned over to the owner.

1.10 MATERIALS, STORAGE AND HANDLING

- A. All components shipped to the job-site and stored on-site shall be stored in a clean, dry storage location.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS/REPRESENTATIVES

- A. Siemens
- B. Johnson Controls
- C. Trane
- D. Automated Logic

E. Engineer-approved Equal

2.2 EQUIPMENT

A. Direct Digital Control (DDC) Controllers:

1. Direct Digital Control (DDC) Controllers shall be field programmable microprocessor based, electronic controllers incorporating direct digital control technology. The DDC controllers shall be capable of performing their assigned control and energy management functions as standalone units or as part of a comprehensive Building Management System. The controllers shall be capable of performing energy management functions including, but not limited to supply air and water reset, duty cycling, morning cool-down and warm-up, solar compensation, unoccupied setback, and real-time scheduling.
2. The controllers shall have built-in, non-volatile, real-time calendar clocks capable of generating real and elapsed time signals in years, months, days of the week, hours, minutes, and seconds, as well as elapsed time in days, hours, minutes, and seconds. The controller shall be provided with a minimum of 72 hour back-up capability protect against loss of time in the calendar clock and the programmed software and provide surge protection on the head end terminal.
3. The controllers shall be capable of interfacing with a standard twisted pair communication channel for local operation and shall be protected with software security code keys to prevent unauthorized access. Where practical, controllers shall be fully distributed and dedicated to an individual piece of equipment or system. When input/output requirements exceed the capacity of a controller, additional controllers shall be connected serially in a daisy chain configuration to allow for the use of a single RS485 interface channel for multiple controllers. Global level controllers shall allow full Internet Protocol (IP) communications through a static IP connection through a 10/100 megabit per second Ethernet protocol.
4. The controllers shall be programmed for the sequences of operation defined hereinafter. The execution of these sequences shall be fully automatic and without operator intervention. The controllers shall sense all of their inputs, test for multiple input programmed conditions and execute appropriate action on valves, dampers, pumps, fans and other equipment. The programmed conditions may include any combination of inputs, outputs, time and the mathematical operations (addition, subtraction, greater than, less than, square root, or absolute value). Program changes shall be entered into the controllers without interruption of the system operation.
5. The controllers shall be completely field programmable from a standard portable programming unit, a CRT terminal or from a remote location through a telephone modem. The program logic shall allow changes without interruption of the system operation.
6. The controllers shall be programmed to examine their inputs for emergency conditions and to automatically initiating the actuation of the appropriate alarm mode.
7. The operator, through a terminal, shall be capable of overriding the programmed control sequence to manually operate the outputs for system checkout. All sequences of operation shall be demonstrated through this simulation technique. The controllers shall be stepped through their sequence to verify system operation. During the maintenance routine, the controllers shall be capable of selectively disabling inputs and outputs without affecting the operations of the remaining inputs and outputs. The controller's status shall be accessible through the ASCII channel. Upon appropriate commands, the controller shall read out time, analog input values, output status, program line number being processed, disabled inputs, disabled outputs, and sequencing program logic. Through the ASCII channel, the controllers shall be capable of printing a data history log for maintenance and troubleshooting of the system.

8. The controllers shall have a minimum of four levels of access available for terminal operation of the unit. The number of functions allowed an operator shall be determined by the level of password that is correctly entered into the controller.
 9. The executive operating system provided with the controllers shall provide for all the functions described herein. The executive system shall provide English error messages to the user when any command or date is entered that cannot be understood by the microprocessor. An editing system shall also be provided for program entry. A program and variable trace routine shall also be provided to allow for easier program testing and debugging.
 10. Digital Controllers used to control terminal equipment, such as variable volume boxes, shall be designed as individual control units. All variables shall be capable of being viewed and changed from the operator's panel, or the portable operator's console.
 11. Digital Controllers used to control variable air volume (VAV) boxes shall include:
 - a. Pressure independent air volume controller capable of controlling air volume within 5% of design air volume from minimum to maximum flow and at all points in between regardless of changes in system static pressure. Air volume maximum and minimum to be factory set and field re-adjustable. Controller shall be capable of 3 set positions: Off, Minimum and Maximum with VAV control from the min. to max. position. Minimum air volume shall be accurately controlled as low as 100 FPM based on inlet duct size. Maximum and minimum air volumes as scheduled on the drawings. If special multi-point velocity sensor is required to meet the specification, this supplier to furnish and coordinate installation with terminal supplier.
 - b. 24 VAC damper actuators. NC control operation as specified.
 - c. Digital output for fan control.
 - d. Digital outputs for each step of electric heat control.
 - e. Temperature sensor.
 - f. A factory calibrated damper assembly and multi-point velocity sensor is specified to be provided with VAV terminals under Section 23 36 00, "Air Terminal Units". Provide 24V power source and wiring to terminal controller on VAV units which do not have a fan under this division, and in addition, a 24V, 40VA control transformer will be supplied on fan powered units by the terminal manufacturer. This supplier shall coordinate all requirements with the terminal supplier.
- B. Input-Output Devices:
1. Temperature Sensors:
 - a. Temperature sensors shall be provided for space, duct, fluid, and outside air sensing which are compatible with the digital controllers. All temperature sensors shall be accurate to .36-degrees F over a range of -30 to 220-degrees F and shall have a demonstrated stability of .04-degrees F over a 10 year period.
 - b. Temperature sensors shall be 10K resistor style.
 - c. All sensors in water lines to be installed in wells. If a permanent thermometer is not located at sensing point, a second well will be installed adjacent for temperature verification purposes.
 - d. All sensors for cooling or heating coil leaving air temperatures shall be serpentine type across entire coil surface area. Sensing tube type is not acceptable.
 - e. Room temperature sensors in public spaces (Auditoriums and Gymnasiums) shall have concealed setpoint adjustment with blank covers.
 - f. Room temperature sensors in private offices and classrooms shall have user accessible setpoint adjustment with setpoint indication and space temperature

indication with adjustable minimum and maximum setpoints capability with digital read outs.

2. Humidity Sensors:

- a. Electronic Humidity Transmitters: Electronic humidity transmitters shall produce a linear 4-20 ma signal over a range of 0 to 100% RH. Accuracy shall be 2% of full scale.
- b. Single point calibration.
- c. Shall be either VAISALA HMD-60U for duct applications and VAISALA HMW- 60U for wall mounted applications or Veris.
- d. Room Humidity sensors shall be integral to the room temperature sensor so that there is only one sensor per room.

3. Pressure Sensors:

- a. Electronic static and differential pressure transmitters shall be stainless steel diaphragm type, with a variable capacitance electrode to produce a linear signal over the appropriate input range. Input ranges shall be available from 0.1 in. H₂O to 7.5 in. H₂O and transmitters shall be selected for 150% of the design pressure. Both zero and span shall be field adjustable. Accuracy shall be $\pm 1\%$ of full scale over the selected range, wherever differential pressure transmitters are subject to damage by disconnecting pressure lines, provide three valve manifolds for disconnection and testing. Based on Setra Model C239.

4. Valves and Operators:

- a. Isolation Type Valves:
 - i. 2 inches and smaller: Ball style, sized for minimum pressure drop.
 - ii. 2-1/2 inches and larger: Butterfly style, sized for minimum pressure drop.
- b. Control Valves:
 - i. Valves shall be provided with equal percentage modulating plugs; renewable composition disk especially compounded for hot or cold water service to assure tight seating. Three-way valves shall be furnished with modulating type plug assemblies and shall have one seat machined integral with the body and the other three-way valve end.
 - ii. Valves shall be sized as indicated or as required to guarantee sufficient size to meet the heating or cooling requirements with specified pressure drops. Water valves shall be sized for 2 psig minimum and 5 psig maximum pressure drop. Valves 2 inches and smaller shall be screwed and valves 2-1/2 inches and larger shall be flanged.
- c. Valve operators:
 - i. Shall be gear driven electronic. Operators shall be of sufficient size to ensure smooth positive operation and tight shut-off against system pressure.
 - ii. Electronic operators shall be of the positive gear driven type using a brushless DC motor with built-in mechanical stops and electronic current limiting circuit to prevent burn-out. The drive motor shall be microprocessor controlled and capable of accepting a 4-20 mA, 0-10 V DC, 0-20 V Dc phase cut, on-off, or floating tri-state control signal as required. Based on Belimo Air controls (USA), Inc.
 - iii. Preheat coil valves and valves on the primary and secondary heating water circuits shall have spring returns. The water valves shall be designed to go to the open position on power or other failure.

- iv. The source of power for valve operation, electronic shall be the responsibility of the BCS Contractor.
- 5. Butterfly Valves and Operators:
 - a. Isolation valves and control valves 4 inches and over may be butterfly type.
 - b. Valves to have 416 stainless steel stem, full lug, cast iron or ductile iron body to permit removal of downstream piping, long neck body extended to allow for a minimum of 2 inches insulation, aluminum bronze or stainless-steel disc, bubble tight EPDM seat, infinite position throttling, Class 150, 20-degrees F to 220-degrees F range.
 - c. Where three way valves are shown, factory furnished T-assemblies with mounted valves and cross linkage may be used.
 - d. Valves to have gear driven electronic operators. Operators to be of sufficient size to ensure smooth, positive operation and tight shut-off against system pressure. Preheat coil valves and valves on the primary and secondary heating water circuits shall have spring returns. The water valves shall be designed to go to the open position on power or other failure.
 - i. Shall be gear driven electronic. Operators shall be of sufficient size to ensure smooth positive operation and tight shut-off against system pressure.
 - ii. Electronic operators shall be of the positive gear driven type using a brushless DC motor with built-in mechanical stops and electronic current limiting circuit to prevent burn-out. The drive motor shall be microprocessor controlled and capable of accepting a 4-20 mA, 0-10 V DC, 0-20 V Dc phase cut, on-off, or floating tri-state control signal as required. Based on Belimo Air controls (USA), Inc.
 - iii. Preheat coil valves and valves on the primary and secondary heating water circuits shall have spring returns. The water valves shall be designed to go to the open position on power or other failure.
 - iv. The source of power for valve operation, electronic shall be the responsibility of the BCS Contractor.
 - e. The source of power for valve operation, electronic shall be the responsibility of the BCS Contractor.
 - f. Based on Keystone Fig. AR2.
- 6. Dampers and Operators:
 - a. Provide outdoor air control dampers with the following features:
 - b. Frame: aluminum channel with corner braces.
 - c. Blade: 6 inches maximum width, opposed blade, aluminum airfoil.
 - d. Axles: 1/2 inch hex axle stainless steel shaft, secured tight to the blade; non-stick, non-corrosive, molded synthetic bearings.
 - e. Control Shaft: 6" x 1/2" diameter, ~~galvanized steel~~ stainless steel control shaft with outboard support bearing.
 - f. Actuator Bracket: Concealed in damper frame, ~~galvanized steel~~ stainless steel.
 - g. Seals: edge and jam seals.
 - h. Leakage Rates: Maximum leakage rates shall not exceed the following values when tested at 1 inch WG pressure differential per AMCA Publication 500.

Damper Width	Leakage Rate
12 inches	65 CFM/SF
24 inches	50 CFM/SF
36 inches	40 CFM/SF
48 inches	40 CFM/SF

- i. Performance specifications are based on Ruskin CD50. Other products satisfying the specifications are acceptable.
 - j. Electronic operators shall be of the positive gear driven type using a brushless DC motor with built-in mechanical stops and electronic current limiting circuit to prevent burn-out. The drive motor shall be microprocessor controlled and capable of accepting a 4-20 mA, 0-10 V DC, 0-20 V DC phase cut, on-off, or floating tri-state control signal as required. Based on Belimo Air Controls (USA), Inc., Invensys DuraDrive and Tamco.
 - k. Actuators for outdoor air and exhaust air dampers shall have spring return, and the dampers shall be designed to go to the closed position on power or other failure.
7. Smoke Detectors:
- a. Smoke detectors (SD) will be furnished and installed by Division 26 - Electrical and Division 23 – Mechanical. (Refer to Specification Section 23 33 00). Detectors will be required in all air handling systems greater than 2000 CFM. Detectors will be required in both supply and return ducts of air handling units or on multi-story buildings in the return at each floor. The detectors shall be wired to shut-down the fans and indicate status to the DDC controls. In the case of an engineered smoke control system, they shall be wired to control as specified and shall be interlocked with the fire alarm system.
8. High limit thermostats (FS) shall be provided for each exhaust fan and shall be of the manual reset type. Thermostats shall be UL listed and shall be wired to shut down their respective fans should the temperature in the duct rise above 125-degrees F (adj.).
9. Low limit thermostats (FR) shall be provided as indicated and shall be wired to shut down their respective unit should the temperature at any point on its sensing element fall below 35-degrees F (adj.). Thermostats shall require manual reset. Provide 1 foot of sensing element for each 2 sq. feet. of duct cross section.
10. Panels:
- a. All relays and similar devices shall be mounted within Control Panels. Quantity and location of control panels shall be dictated by the controls contractor's system architecture.
 - b. Control panels shall be dust tight and furnished with hinged locking doors. Provide an engraved nameplate on the face of the panel clearly describing its function. All devices located within the panel shall be clearly labeled. All wiring within the panel shall be in accordance with NEMA, UL standard, NEC and local codes. Details and proposed mounting location of each panel shall be submitted prior to construction.
 - c. All panels shall be factory prewired and pre-piped to terminal strips prior to arrival at job site. The wiring shall be installed orderly and easily identifiable.
 - d. Provide wiring diagram mounted inside door with plastic protective covering.
11. Relays:
- a. All relays shall be plugged in, interchangeable, mounted on a circuit board and wired to numbered terminal strips.
 - b. Start/stop relay modules shall provide either momentary or maintained switching action as appropriate for the motor being started.

12. Differential Pressure Switches: Binary differential pressure sensors shall be used to indicate pump and fan operation and for indicating high pressure drop across filters. These sensors shall be of the diaphragm type and shall be adjustable and furnished in ranges compatible with their service.
13. Current Sensing Relays:
 - a. Solid state switch which operates when current level sensed by internal current transformer exceeds the threshold value set by the adjusting device. Internal circuits totally powered by induction from line being monitored.
 - b. Current range and switching characteristics as required for intended duty.
14. Line Voltage Electric Thermostats:
 - a. Where mechanical equipment such as certain exhaust fans or unit heaters are indicated to be controlled directly from a space thermostat, provide a thermostat of either the heating or cooling type depending upon the application.
 - b. All line voltage thermostats shall be rated to carry 125% of the load of the controlled device.
15. Thermostat/Temperature Sensor Guard:
 - a. Wire guard with steel base.
 - b. Cast aluminum guard with steel base.
 - c. Clear plastic guard with solid base and tumbler type key lock.
 - d. Contractor to verify the location of these guards with engineer and Owner's representative.
16. Air Flow Measuring Station: Duct and plenum mounted airflow measurement devices. The following is the only acceptable manufacturer:
 - a. Tek-air's Vortek VT-5000
 - b. Alternatives requesting acceptance as "equals" less than 60 days prior to bid date or products submitted in non-conformance with the requirements of this specification will not be considered.
 - c. For any product to be considered for substitution a written section-by-section detailed exceptions/compliance document shall be submitted to the Engineer before any approval will be considered.
 - d. Any product offered as an equal shall make a working demo available for a side by side evaluation in the specifying engineer's office.
 - e. The working demo must be able to demonstrate airflow measurement throughout the entire specified range (50 - 5000 FPM), repeatability, response time and specification compliance. Providing a working demo in and of itself does not constitute its approval.
 - f. Provide airflow/temperature measurement devices (ATMD) where indicated on the plans or as recommended by an authorized representative. Fan inlet measurement devices shall not be used unless specifically indicated on the plans.
 - g. Each ATMD shall consist of one or more sensor probes and a single, remotely mounted, microprocessor-based transmitter capable of independently processing up to 16 independently wired sensor assemblies.
 - h. Each sensor node shall contain two individually wired, hermetically sealed bead-in-glass thermistors.
 - i. Thermistors shall be mounted in the sensor node using a marine-grade, waterproof epoxy. Thermistor leads shall be protected and not exposed to the environment.

Thermistor leads shall not be fastened to the thermistor semiconductor substrate by weld or solder connections.

- i. The airflow rate of each sensor assembly shall be equally weighted and averaged by the transmitter prior to output. All integrated circuitry shall be temperature rated as 'industrial-grade'. Submissions containing 'commercial-grade' integrated circuitry are not acceptable.
- ii. The temperature of each sensor assembly shall be velocity weighted and averaged by the transmitter prior to output.
- iii. Each transmitter shall have a 16-character alpha-numeric display capable of displaying airflow, temperature, system status, configuration settings and diagnostics.
- iv. Devices using chip-in-glass or diode-case chip thermistors are not acceptable.
- v. Devices using less than two thermistors in each sensor assembly are not acceptable.
- vi. Devices having electronic circuitry mounted in or at the sensor probe are not acceptable.
- vii. Pitot tubes and arrays are not acceptable.
- viii. Vortex shedding devices are not acceptable.
- ix. Duct and Plenum Probes
 - a) Probes shall be constructed of extruded, gold anodized, 6063 aluminum tubes or optionally of Type 316 stainless steel tubes. All internal wires within the tube shall be Kynar coated. PVC insulated conductors are not acceptable.
 - b) The number of individual sensor nodes provided for each location shall be as follows:

Duct or Plenum Area (ft ²)	Total # Nodes / Location	Duct or Plenum Area (m ²)
<= 1	1 or 2	<= 0.093
>1 to <2	4	>0.093 to < 0.372
2 to < 4	6	0.372 to < 0.743
4 to < 8	8	0.743 to < 1.115
8 to <16	12	1.115 to < 1.486
>=16	16	>= 1.486

- c) Sensor probe design shall be capable of providing up to 8 sensor nodes per probe.
- d) The minimum operating airflow range shall be 0 to 5,000 FPM (25.4 m/s) unless otherwise indicated on the plans.
- e) Each ducted sensor probe shall have an integral, U.L. Listed, plenum rated cable. Cable jackets and conductor insulation shall be FEP, Teflon-FEP or Neoflon-FEP. Cables shall include a terminal plug for connection to the remotely mounted transmitter. All terminal plug interconnecting pins shall be gold plated. PVC jacketed cables or PVC insulated conductors are not acceptable with ducted sensor probes.

17. Carbon Dioxide Monitor - Controller:

- a. CO2 sensing cell shall consist of a nondispersive infrared carbon dioxide gas cell that uses a pulse source and has no free air optical path. Output shall be linearized 4-20 mA for use with 24 VDC input. The unit shall be specifically designed for a wall application. Unit shall have span adjustment. The unit shall have no moving parts.
- b. Minimum Requirements:
 - i. Range: 0-2,000 ppm
 - ii. Accuracy: 3% of full scale
 - iii. Repeatability: 1% of full scale
 - iv. Zero Drift at Constant Temperatures: 100 ppm per 24 hours (random not cumulative)
 - v. Max. allowable Drift in 1 year: 20 ppm
- c. Unit shall not require calibration for a period of 1 year or more.
- d. Unit shall have a 5 year warranty.
- e. Approved Manufactures:
 - i. System Integrator's brand-named product.
 - ii. Valtronics
 - iii. Telaire
 - iv. Veris

18. Indoor Air Quality (IAQ) Sensor and Controller:

- a. Sensor to be located in return air duct. Sensor to supply a frequency modulated output signal superimposed on the DC supply as the contamination level in the air changes.
- b. The signal to be processed in the controller and compared to the setpoint. An increasing contamination concentration will cause the sensor to respond with an increasing output which will result in a proportional output from the controller.
- c. Sensor to carbon monoxide, carbon dioxide, formaldehyde and hydrocarbons which make up common indoor air pollution. The sensor shall respond to carbon dioxide and be capable of controlling to a limit as low as 500 PPM.

19. Photoelectric Sensor: Reflex type units containing the source and detector in the same enclosure using a remote reflector. An infrared light beam shall be emitted with a range of approximately 30 feet. Sensors shall be similar to Redington series 97 and 98. Installation may require recessing into mounting surface - coordinate with Architect and receive the Architect's approval prior to mounting sensors or reflector.

20. Control Air Tubing:

- a. Copper hard drawn or annealed.
- b. Fittings: Copper or brass, sweat or flare compression type.
- c. Non-metallic FR Polytubing. Tubing shall be suitable for use in return air plenums.

21. Programmable Lighting Panels:

- a. Programmable lighting panels shall contain up to 42 individual circuits as required. Each circuit shall contain a properly sized breaker and lighting contactor initiator. Lighting contactor initiator shall receive a signal from the Building Automation System to provide individual control for each lighting circuit.

- b. Refer to the electrical drawings and schedules for additional information and requirements.
- c. Programmable lighting panels are to be furnished by this contractor. Installations and power wiring are by Division 26.

22. Smoke dampers shall be as specified in Section 23 33 00, "Air Duct Accessories".

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. All system components and appurtenances shall be installed in accordance with the manufacturer's instructions and requirements. All necessary interconnections, services and adjustments required for a complete tie-in to the existing operable system shall be provided by this contractor.
- B. The contractor shall review all contract drawings and specifications, including addenda and referenced material and shall visit the job site, if applicable in order to become informed prior to bidding as to existing conditions and limitations of the project. The contractor shall bring exceptions and inconsistencies in drawings, specifications, addenda, referenced material, other contract documents and site conditions to the attention of the engineer.
- C. The location of material, equipment and devices shown on the drawings are approximate and are subject to such revisions as may be necessary or desirable at the time that the work is being installed. The contractor shall install the work in relation to existing conditions. Should project conditions require rearrangement, or if equipment or accessories can be installed to better advantage in a different manner, prepare and submit five copies of shop drawings indicating the proposed rearrangement for the Engineer's review.
- D. Chilled Water Systems: Furnish a test well for installation under Section 23 05 19, adjacent to each temperature sensor where a fixed thermometer is not provided.
- E. Control Wiring:
 - 1. All wiring incidental to the building control system, including electrical interlocks shall be included in this section and provided as part of the building control system.
 - 2. All control wiring shall be run in conduit where required by code or where the possibility of harm or permanent damage exists. In addition, all wiring installed below 8 feet or below suspended ceilings shall be installed in conduit.
 - 3. Any wiring not installed in conduit shall be multi-conductor cable, with individual wires color codes for ease of installation and troubleshooting. All wiring installed above a plenum ceiling shall be Teflon coated and rated for plenum service.
 - 4. All wiring shall be concealed wherever possible and installed in a neat and workmanlike manner. All wiring and conduit shall be run parallel or perpendicular to the building structure. All cables shall be supported at frequent intervals and attached to supports by the use of nylon tie-wraps.
 - 5. Control wiring shall conform to the requirements of Section 23 05 18, "Control Wiring" and all applicable section of Division 26.
- F. Terminal Controls: Unless provided by the terminal manufacturer, Direct Digital Controllers controlling VAV boxes, damper operators and velocity transmitters shall be shipped to the VAV box manufacturer for factory installation. Provide the box manufacturer with complete wiring and piping diagrams and detailed installation instructions. Box manufacturer shall furnish and install 24 volt transformer.
- G. System Start-up and Check-out:
 - 1. The manufacturer shall provide a control technician for the start-up, check-out of all input and outputs, implement and check the software function and submit report on check-out of each system.

2. Demonstrate to the Owner that all functions are operating as per final approved sequences.
 3. The manufacturer shall provide a control technician for the training of the Owner's operators as detailed in Division 1 Requirements.
- H. System Acceptance & Trend Log Submittal:
1. After completion of the installation, check-out and control loop tuning, and trend logs shall be submitted, as listed below, to demonstrate the satisfactory performance of the system and to serve as a data base for the owner's future use.
 2. The trend logs shall be organized in spread sheet format and presented in both tabular and graphical form. A disc or tape copy of each final accepted trend log set shall also be provided. Trend logs shall be as follows:
 3. Control Stability Trend Logs:
 - a. Each digital or analog output to valves, dampers, adjustable frequency drives and other control devices shall be included.
 - b. Scan time shall be at five second intervals for a duration of ten minutes.
 - c. Start of the sets shall be immediately after change from one mode to another, i.e., unoccupied to occupied, no economizer to economizer, off to on, etc. Only one log will be required for each output as long as it addresses all controlled elements.
 - d. Where control of a piece of equipment is by factory furnished packaged controls, then the controlled temperature which is monitored shall be included. For instance, where a chiller is controlled by its own control system and control is from leaving chilled water temperature, then leaving chilled water temperature shall be included in the log set.

3.2 EQUIPMENT ADDITIONAL REQUIREMENTS

- A. Smoke Detectors:
1. Smoke detectors will be furnished and installed under Division 26. Power wiring, alarm circuit and supervisory circuit will be provided under Division 26. Control wiring to auxiliary contacts required to shut-down fans (hard wired) and alarm BCS shall be provided by this Section.
 2. All detectors shall function properly; equipment shall shut down and dampers must be tested for operation prior to building occupancy with design air flow to ensure operation under normal conditions. Provide a letter to the Owners Representative certifying that these tests have been conducted.
 3. When an engineered smoke control system is specified, the smoke detectors shall function as specified.
- B. Air Flow Measuring Stations:
1. Install air flow measuring stations on the inlet bells of the fan as specified. 120V AC power wiring and control wiring will be provided under this section.
 2. For airflow measuring stations that cannot be mounted on the inlet bells of the fan, furnish air flow measuring stations for installation under Section 23 33 00 - Air Duct Accessories wiring will be provided under this section.
 3. Coordinate location, duct size and confirm that there is proper space for access before releasing for fabrication. Coordinate installation requirements with sheet metal sub-contractor as specified in Section 23 33 00, "Air Duct Accessories".
- C. Dampers:
1. Unless specifically stated otherwise, the outside air, return air and relief air dampers for all air handling units shall be provided under this section of the specifications. Where damper sizes are not shown on drawings, size outdoor air and relief air dampers at 1500 ft/min.

- and return air dampers at 2000 ft/min. face velocity. Discharge dampers shall be furnished on systems over 5000 CFM. Where so indicated, provide separate minimum and maximum
2. O.A. damper.
 3. Return air, relief air and discharge dampers to be smoke rated on systems over 15,000 CFM and arranged to close in response to smoke detector or function as specified in an engineered smoke control system.
 4. Turn dampers over to sheet metal contractor for installation as specified in Section 23 33 00 - Air Duct Accessories.
- D. Line Voltage Thermostats: (Used only for exhaust fans only, not for classrooms HVAC Systems). Provide and wire including necessary outlet box, conduit box and all interconnecting wiring.
- E. Room Temperature Sensors:
1. General:
 - a. Provide a room temperature sensor in each location shown on the drawings.
 - b. Each room temperature sensor shall be wired to a local control device that shall maintain the established setpoints within the space in response to time, mode and temperature inputs.
 - c. Each sensor shall have a digital display and an override button.
 2. Room Temperature Sensor Mounting:
 - a. In classrooms and offices, each room sensor shall be installed immediately inside door, next to the light switch with its center approximately 4'-0" above the floor. Each room sensor mounted on an exterior wall of the building with an insulating block of wood or other approved material.
 - b. In public spaces and other unsupervised areas, locate temperature sensors with its center approximately 7'-0" above the floor.
 - c. Devices with exposed setpoint adjustment, override switches, or any other operable feature shall be installed at a height in compliance with ADA for the location intended.
- F. Thermostat/Temperature Sensor Guard: For schools, install in all public spaces and other unsupervised areas (Lockable Lexan covers). Not required in offices or classrooms unless called for on the drawings.
- G. Carbon Dioxide Monitor - Controller: Install in the space or duct as shown on the drawings.
- H. Indoor Air Quality Sensor:
1. Install in return airstream as shown.
 2. Set IAQ controller at 100% control point. With ASHRAE recommended O.A. CFM as listed in the schedule or provided by the engineer and the building normal occupancy, trend the output signal for 30 days. At the end of the 30 day period, set the IAQ controller at a setpoint equal to the "lowest air quality signal" (poorest air quality). Controller shall then operate to modulate the O.A. damper from the "highest minimum O.A." quantity to the "lowest minimum O.A." to hold the setpoint. (The "lowest air quality signal" is that output which meets ASHRAE Standard 62 with normal occupancy. Reducing the O.A. below this is permissible due to lower occupancy or less contaminants.

3.3 SOFTWARE ENHANCEMENTS

- A. After the system has operated properly for 90 days following start-up of the final component of the heating and air conditioning systems, an as-built copy of the software shall be transmitted to the owner for permanent record purposes. An allowance shall also be included for any software upgrading or enhancements to improve the system operation or as required for proper operation of the system during the first year of operation. Any changes to the software shall be immediately transmitted to the owner.

3.4 CALIBRATION AND TESTING

- A. The Building Control Contractor shall calibrate all building controlled system equipment and verify operation before this system is placed on-line. All testing, calibrating, and adjusting shall be completed by the contractor prior to the start of the acceptance test; including all DDC control loops, interlocks, sequences, energy management programs, and alarms shall be tested, and proper operation verified.
- B. The Product Integrated Controls shall be factory installed, configured, and tested for stand-alone operation. Specific configuration, such as setpoints and time schedules, shall be completed before the HVAC equipment on which it is installed and is placed in operation. All testing, calibrating, and adjusting of individual HVAC equipment PIC controls shall be done as a part of that individual unit start-up and acceptance. Only the PIC's network communications function shall be included with the automation (BCS) acceptance test.

3.5 ACCEPTANCE TEST

- A. After start-up and calibration, the building controls sub-contractor shall submit to the engineer trend logs of all points on each system demonstrating stable and proper operation. The demonstration shall cover the following conditions:
 - 1. Cooling Only (O.A. Temperature > 70-degrees F).
 - 2. Cooling and Heating (O.A. Temperature 55 degrees F to 70 degrees F).
 - 3. Heating Only (O.A. Temperature < 40-degrees F).
- B. The trend logs shall be as follows:
 - 1. 24-hour period at 15-minute intervals.
 - 2. 3 hour start-up period at 5 minute intervals.
 - 3. A total of two sets covering two days during each period are required.
- C. After submission of the logs for any one of the periods, the engineer will review them for acceptability, and if acceptable, schedule a final walk-thru of the system for final acceptance and start of hardware warranty.
- D. During the hardware warranty period, the controls sub-contractor shall submit trend data covering the other two periods. Any adjustments or modifications to get acceptable results in each period shall be considered to be part of the warranty obligation.

3.6 SEQUENCE OF OPERATION

- A. See drawings for sequence of operation.

END OF SECTION

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SECTION 23 33 00 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.
- B. Refer to Division 1 for all requirements pertaining to General Provisions.

1.2 WORK INCLUDED

- A. Duct access doors.
- B. Fire doors.
- C. Fire dampers.
- D. Smoke dampers.
- E. Smoke/Fire dampers.
- F. Backdraft dampers.
- G. Volume dampers.
- H. Prefabricated casing panels.
- I. Flexible duct connectors.
- J. Roof mounted air outlets and inlets.
- K. Louver (Exhaust).
- L. Louver (Outside Air Intake).
- M. Hardware Cloth.
- N. Aluminum Brick vent
- O. Install miscellaneous control devices.

1.3 QUALITY ASSURANCE

- A. All products provided for enhancement of Life Safety shall be UL listed and bear the appropriate label stating compliance.
- B. All Products to have a Florida Product Approval Number, as required by the Florida Building Code.
- C. All products located in the conditioned air stream or located in return air plenums shall conform to the NFPA 90A Flame/Smoke/Fuel Contribution of 25/50/0 and all other applicable requirements of NFPA 90A.
- D. Smoke and Smoke/Fire dampers shall be provided with a 60 month from the date of shipment parts only warranty, including freight for all components, including damper operators.
- E. Quality Assurance for Louvers:
 - 1. Source Limitations: Obtain louvers and vents through one source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.
 - 2. Welding: Qualify procedures and personnel according to the following:
 - a. AWS D1.2, "Structural Welding Code - Aluminum."
 - b. AWS D1.6, "Structural Welding Code - Stainless Steel."
 - 3. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

1.4 PERFORMANCE REQUIREMENTS FOR LOUVERS

- A. Structural Performance: Louvers shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act on vertical projection of louvers.
 - 1. Wind Loads: Determine in accordance with the Florida Building Code (current edition).

1.5 SUBMITTALS

- A. Submission for acceptance is required.
- B. Product data, along with installation operation and maintenance instructions, shall be included in the operation and maintenance manuals.
- C. Submit in accordance with Division 1 Requirements.
- D. Submittals for Louvers:
 - 1. Product Data: For each type of product indicated.
 - 2. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other Work. Show blade profiles, angles, and spacing.
 - a. For installed louvers and vents indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation. Include summary of forces and loads on walls and jambs.
 - 3. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver.
 - a. Wind-Driven Rain.
 - b. Air-Performance.

1.6 PROJECT CONDITIONS FOR LOUVERS

- A. Field Measurements: Verify louver openings by field measurements before fabrication and indicate measurements on Shop Drawings.
 - 1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish opening dimensions and proceed with fabricating louvers without field measurements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Duct Access Doors:
 - 1. Air Balance, Inc.
 - 2. Cesco Products
 - 3. Greenheck, Inc.
 - 4. Nailor Industries, Inc.
 - 5. Nystrom
 - 6. Prefco Products, Inc.
 - 7. Ruskin Manufacturing Co.
 - 8. Safe Air Inc.
- B. Fire Doors:
 - 1. Air Balance, Inc.

2. Cesco Products
 3. Greenheck, Inc.
 4. Nailor Industries, Inc.
 5. Nystrom
 6. Prefco Products, Inc.
 7. Ruskin Manufacturing Co.
 8. Safe Air Inc.
- C. Fire Dampers:
1. Air Balance, Inc.
 2. Cesco Products
 3. Greenheck, Inc.
 4. Nailor Industries, Inc.
 5. Prefco Products, Inc.
 6. Ruskin Manufacturing Co.
 7. Safe Air Inc.
- D. Smoke Dampers:
1. Air Balance, Inc.
 2. Cesco Products
 3. Greenheck, Inc.
 4. Nailor Industries, Inc.
 5. Prefco Products, Inc.
 6. Ruskin Manufacturing Co.
 7. Safe Air Inc./Dowco
- E. Smoke/Fire Dampers:
1. Air Balance, Inc.
 2. Cesco Products
 3. Greenheck, Inc.
 4. Nailor Industries, Inc.
 5. Prefco Products, Inc.
 6. Ruskin Manufacturing Co.
 7. Safe Air Inc./Dowco.
- F. Backdraft Dampers:
1. Air Balance, Inc.
 2. Cesco Products
 3. Greenheck, Inc.
 4. Nailor Industries, Inc.
 5. Prefco Products, Inc.
 6. Ruskin Manufacturing Co.
 7. Safe Air Inc./Dowco.

G. Volume Dampers:

1. Greenheck, Inc.
2. Air Balance, Inc.
3. Arrow United Industries, Inc.
4. Cesco Products
5. Nailor Industries, Inc.
6. Prefco Products, Inc.
7. Ruskin Manufacturing Co.
8. Safe Air Inc./ Dowco.

H. Prefabricated Casing Panels:

1. IAC
2. Ruskin
3. Semco
4. United Sheetmetal
5. Vibro Acoustics

I. Flexible Duct Connectors:

1. Ductmate Industries, Inc.
2. Duro-Dyne
3. Elgen
4. Ventfabric

J. Roof Mounted Air Outlets and Inlets:

1. Air Balance, Inc.
2. Cesco Products
3. Greenheck, Inc.
4. Leader, Inc.
5. Loren Cook
6. Ruskin Manufacturing Company

K. Louvers (Exhaust)- No Substitutions Accepted:

1. Greenheck, Inc.
2. Ruskin Company; Tomkins PLC.
3. United Enertech

L. Louvers (Outside Air Intake)- No Substitutions Accepted:

1. Greenheck, Inc.
2. Ruskin Company; Tomkins PLC.
3. United Enertech

M. Hardware Cloth:

1. McNichols Co.
2. or equal.

N. Aluminum Brick Vent

1. Greenheck, Inc.
2. Ruskin Manufacturing Company
3. United

2.2 FABRICATION

A. Duct Access Doors:

1. Low Pressure Ductwork:
 - a. Rating up to 2 inch wg positive or negative.
 - b. Frame: Minimum 22-gauge galvanized steel or aluminum, minimum 5/8 inch knock over edge, neoprene gasket between frame and duct and frame and door.
 - c. Door: Minimum 24-gauge galvanized steel or aluminum, continuous hinge and cam latches or minimum 2 cam latches, double wall construction, fiberglass insulated thickness to match ductwork.
 - d. Based on Ruskin Manufacturing Co. ADH24.
2. High Pressure Ductwork:
 - a. Rating: Up to 10 inch wg positive pressure.
 - b. Frame: Minimum 16-gauge galvanized steel with "Z" shaped reinforced corners, polyurethane gasket between frame and duct and frame and door.
 - c. Door: Minimum 16-gauge galvanized steel or aluminum, minimum 2 spring latches, double wall construction, fiberglass insulated with thickness to match ductwork.
 - d. Based on Ruskin Manufacturing Co. ADHP-3.

B. Fire Doors:

1. Rating: 3 hours (UL approved for installation in Class "A" wall construction).
2. Minimum 24-gauge galvanized steel frame suitable for connection to ductwork without transition, minimum 24-gauge galvanized steel curtain type blades located out of the airstream, thickness coordinated with wall construction. Where an active smoke control system exists (refer to Section 23 09 93) the damper shall be capable of closing in an airstream moving at a minimum of 2000 feet per minute and operating at 4 inch w.g. pressure (dynamic damper).
3. Sleeves: UL listed minimum gauge galvanized steel with welded construction corners. Roll formed sleeves will not be acceptable unless contractor guarantees in writing to seal voids in sleeve with UL approved sealer to limit air leakage. Length of sleeve shall be coordinated with the wall or floor.
4. Operation: Stainless steel constant force closure spring.
5. Link Setting: 160-degrees F or 165-degrees F
6. Based on Ruskin Manufacturing Co., IBD23 Style B (Static Systems).
7. Based on Ruskin Manufacturing Co., DIBD23 Style B (Active smoke control systems only).

C. Fire Dampers:

1. Rating: 1-1/2 hours (UL approved for installation in 2 hour walls).
2. Construction: Minimum 24-gauge galvanized steel frame suitable for connection to ductwork without transition, minimum 24-gauge galvanized steel curtain type blades located out of the airstream, thickness coordinated with wall construction. Where an active smoke control system exists (refer to Section 23 09 93) the damper shall be capable of

closing in an airstream moving at a minimum of 2000 feet per minute and operating at 4 inch w.g. pressure (dynamic damper).

3. Sleeves: UL listed minimum gauge galvanized steel with welded construction corners. Roll formed sleeves will not be acceptable unless contractor guarantees in writing to seal voids in sleeve with UL approved sealer to limit air leakage. Length of sleeve shall be coordinated with the wall or floor.
4. Operation: Stainless steel constant force closure spring.
5. Link Setting: 160-degrees F or 165-degrees F.
6. Based on Ruskin Manufacturing Co. IBD2 Style B. (Static Systems).
7. Based on Ruskin Manufacturing Co., DIBD2 Style B. (Active smoke control systems only).

D. Smoke Dampers:

1. Low and Medium Pressure Ductwork:
 - a. UL labeled under UL 555S low leakage rated, no more than 10 CFM/SF @ 1 inch w.g. (UL Class II) after exposure to 1000-degrees F for 1 hour (non-degradable). Classified for both horizontal and vertical mounting.
 - b. Construction:
 - i. Frame 16 galvanized steel.
 - ii. Damper Blades: 14-gauge true airfoil design constructed of aluminum or stainless steel of low leakage non-heat degradable design with friction free silicone rubber edge type for a smoke seal to 450-degrees F incorporated into blade and frame shapes. Blade shall be suitable for installation in systems with a maximum velocity of 4,000 FPM and 8 inch w.g. pressure at closure.
 - c. Damper operation by means of an electric actuator 120V AC, 24V AC or signal from smoke detector alarm circuit. Electric motor actuator to be UL listed with damper assembly for power open, spring closed operation with a maximum travel time of 15 seconds. Motor furnished with all connecting linkage and mounting hardware.
 - d. Damper and actuator shall be provided with a 60-month warranty as described in Paragraph 1.3.C.
 - e. Based on Ruskin Manufacturing Co., SD60-II.

E. Smoke/Fire Dampers:

1. Low and Medium Pressure Ductwork:
 - a. UL labeled under the following standards:
 - i. UL 555 - 1-1/2 hr. fire endurance.
 - ii. UL 555S - Low leakage rated, no more than 10 CFM/SF @ 1 inch w.g. (UL Class II) after exposure to 1000-degrees F for 1 hour (non-degradable).
 - iii. Classified for both horizontal and vertical mounting.
 - b. Construction: Single damper designed and rated for combination smoke/fire duty.
 - i. Frame: 16 ga. galvanized steel.
 - ii. Damper Blades: 14-gauge true airfoil design constructed of galvanized steel of low leakage non-heat degradable design with friction free inflatable silicone coated fiberglass material to maintain smoke leakage rating to a minimum of 450-degrees F and galvanized steel for flame seal to 1900-degrees F. Blade shall be suitable for installation in systems with a maximum velocity of 2,000 FPM and 4 inch w.g. pressure at closure.
 - iii. Duct sleeves are provided by others.

- c. Operation:
 - i. Smoke/fire damper operation by means of an integral resettable and re-useable UL listed electric-ambient temperature link, UL listed releasing device and mechanical lock assembly. Link activated by either electric, 120V AC or 24VAC signal from smoke detector alarm circuit or 350-degrees F duct ambient temperature. Damper shall be capable of being reopened by remote signal when the duct temperature drops to 150-degrees F. Electric motor actuator shall be UL listed with the damper assembly for power open/spring closed operation. Motor actuator shall be factory furnished with all connecting linkage and mounting hardware and shall be factory tested for proper operation.
 - ii. Damper and actuator shall be provided with a 60 month warranty as described in Paragraph 1.3.C.
 - d. Based on Ruskin Manufacturing, Co., FSD60-2.
- F. Backdraft Dampers:
- 1. Low Pressure Ductwork:
 - a. Rating: Up to 1 inch wg positive or negative.
 - b. Frame: Minimum .064 inch stainless steel or extruded aluminum.
 - c. Blades: Minimum .064 inch stainless steel or extruded aluminum parallel blade action, brass bearing, non-ferrous or de-iron pivot pins, gasketed blades.
 - d. Accessories: Counterbalance and weights suitable for assisting or retarding as indicated on the drawings.
 - e. Based on Ruskin Manufacturing, Co. CBD4.
- G. Volume Dampers:
- 1. Provide volume dampers where indicated, in all branch ductwork and construct as follows:
 - a. Provide single blades to a maximum of 10 inch blade width.
 - b. Provide inside end synthetic bearings and locking quadrants with wing nuts.
 - c. Friction locks are not permitted.
 - d. Break damper blades on both edges for stiffness.
 - e. Provide multi-blades on dampers 12 inches and larger with inside pins and molded synthetic bearings, and 2 inches wide by 1/8 inch thick structural stainless steel channel frame.
 - f. Provide stainless steel connecting bar with molded synthetic bearings on multi-blade dampers.
 - g. Provide standoff bracket for installation in externally insulated duct.
 - h. Based on Ruskin Manufacturing, Co. MD35 for rectangular ducts (MDSR25 for round ducts) with velocities up to 1500 feet per minute.
 - i. Based on Ruskin Manufacturing, Co. CD30AF1 for rectangular ducts (CDR82 for round ducts) with velocities over 1501 feet per minute.
- H. Prefabricated Casing Panels:
- 1. Panel sections shall consist of an outer sheet of 18 gauge and an inner sheet of 22-gauge galvanized steel. Inside panel surfaces shall have 3/32 inch diameter perforations on 3/16 inch centers.
 - 2. Panels shall be completely metal enclosed; shall be minimum two 4 inches thick; and the space between inner and outer surfaces shall be filled with acoustic material which will not settle, shed, or dust.

3. Housing shall be factory fabricated and field assembled with joining members serving to provide structural rigidity to 10 inches water pressure differential, either positive or negative. Structure shall be tested and rated for known structural deflection.
4. The joining members shall be fabricated from galvanized sheet steel, minimum 20 gauge, and shall be arranged to provide a pressure tight air seal against 10 inches pressure differential, either positive or negative. Use Sealing Mastic when joining parallel panels, roof to wall panels, joints and corner joints. Housing shall be fabricated to withstand floor and roof loads of 40 pounds per square foot plus any concentrated loads.
5. Assembly shall be secured against the separation forces of air pressure with cadmium plated metal fasteners.
6. The panel shall have minimum airborne sound transmission loss when tested according to ASTM E90-70.

Transmission Loss in DB Octave

Band HZ	63	125	250	500	1K	2K	4K
Loss	30	16	24	35	45	52	58

7. The thermal conductivity of the panel shall not exceed 0.07 Btu/hr-square foot-degrees F.
 8. Insulated access doors shall be provided. Doors shall be constructed of 20-gauge galvanized steel, adequately hinged. Doors shall open against the pressure force and be equipped with safety features such as latches operable from both sides of door and wire glass double pane windows not less than 6" x 6" square. Doors shall seat against neoprene gaskets. Doors shall have Ventfabrics No. 260 "Ventlok" latches.
 9. All openings in the casing for ductwork connections shall be cut and framed at the factory by the panel manufacturer. All openings shall be sealed to prevent air leakage and condensation in accordance with the manufacturer's instructions.
 10. All joints, corners, etc., in the panels and floor shall be so designed that no direct path for sound or air leakage can occur.
 11. The casing manufacturer shall guarantee that the casings, doors and housings shall meet the acoustical, thermal and air pressure performance specified, when installed in accordance with the manufacturer's recommendations and as noted herein.
- I. Flexible Duct Connectors (Required on all duct transitions from AHU to ductwork):
1. Indoor Applications:
 - a. Material: Heavy glass fabric double - Coated with neoprene, Minimum of 30 oz/sy, Resistant to abrasion and damage due to repeated flexing, waterproof and airtight, minimum 26-gauge galvanized steel or .032 inch aluminum edge a minimum of 2-1/2 inches wide each side. Coordinate the flex width with the schedule in 3.3 - Schedule.
 - b. Rating:
 - i. Temperature: 10-degrees F to 200-degrees F
 - ii. Pressure: 10 inch positive - 10 inch negative
 - c. Based on Ventfabric and Ventglass.
 2. Outdoor Applications:
 - a. Heavy glass fabric double - Coated with neoprene, Minimum of 30 oz/sy, resistant to abrasion and damage due to repeated flexing, waterproof, airtight and resistant to damage from direct sunlight, minimum 26-gauge galvanized steel or .032 inch aluminum edge at minimum of 2-1/2 inches wide each side. Coordinate the flex width with the schedule in 3.3 - Schedule.
 - b. Rating:
 - i. Temperature: 10-degrees F to 250-degrees F

- ii. Pressure: 10 inch positive - 10 inch negative
 - c. Based on Ventfabrics Ventlon.
- J. Louvers (Exhaust):
 - 1. Subject to compliance with requirements, provide either of the following unless a specific orientation is indicated:
 - 2. Horizontal Storm-Resistant Louver.
 - 3. Frame and Blade Nominal Thickness: As required to comply with structural performance requirements, but not less than 0.080 inch.
 - 4. Performance Requirements:
 - a. Wind-Driven Rain Performance: Not less than 99 percent effectiveness when subjected to a rainfall rate of 3 inches per hour and a wind speed of 29 mph at a core-area intake velocity of 700-fpm.
 - b. Air Performance: Not more than 0.10 inch wg static pressure drop at 600-fpm free-area intake velocity.
 - c. Free Area: Not less than 7.0 sq. ft. for 48 inch wide by 48 inch high louver.
 - 5. AMCA Seal: Mark units with AMCA Certified Ratings Seal.
 - 6. Acceptable Products - Horizontal:
 - a. Greenheck EHH-501-X.
 - b. Ruskin EME-520-MD.
 - c. UEC SED-5.
 - d. Must be Miami Dade NOA approved and also have a Florida Product Approval Number.
 - 7. EHPA Acceptable Products - Vertical:
 - a. Based on Ruskin Manufacturing, Co. EME6325D /CD-50 Miami Dade/Hurricane Tested & Missile Impact Tested and approved. (Vertical Blade). This louver shall be used on ALL EHPA Buildings as specified on the Architectural Drawings.
- K. Louvers (Outside Air Intake):
 - 1. Subject to compliance with requirements, provide either of the following unless a specific orientation is indicated:
 - a. Horizontal Storm-Resistant Louver.
 - 2. Frame and Blade Nominal Thickness: As required to comply with structural performance requirements, but not less than 0.080 inch.
 - 3. Performance Requirements:
 - a. Wind-Driven Rain Performance: Not less than 99 percent effectiveness when subjected to a rainfall rate of 3 inches per hour and a wind speed of 29 mph at a core-area intake velocity of 700-fpm.
 - b. Air Performance: Not more than 0.10 inch wg static pressure drop at 600- fpm free-area intake velocity.
 - c. Free Area: Not less than 7.0 sq.ft. for 48 inch wide by 48 inch high louver.
 - 4. AMCA Seal: Mark units with AMCA Certified Ratings Seal.
 - 5. Acceptable Products - Horizontal:
 - a. Greenheck EHH-501-X.
 - b. Ruskin EME-520-MD.
 - c. UEC SED-5.

- d. Must be Miami Dade NOA approved and also have a Florida Product Approval Number.
- 6. EHPA Acceptable Products - Vertical:
 - a. Based on Ruskin Manufacturing, Co. EME6325D /CD-50 Miami Dade/Hurricane Tested & Missile Impact Tested and approved. (Vertical Blade). This louver shall be used on ALL EHPA Buildings as specified on the Architectural Drawings.
- L. Hardware Cloth: 4 mesh galvanized steel, plain weave with .035 wire.
- M. Aluminum Brick Vent
 - 1. Extruded aluminum, 0.100 inch minimum wall thickness for frame and blades. Frame depth 4 inches.
 - 2. 8-1/8" w x 7-3/4" h with 1-1/2 flanged frame and aluminum mesh screen.
 - 3. Finish to be "Kynar 500" fluoropolymer coating having dry thickness of approximately 1.2 mils when baked at 450-degrees F. Color to be selected by Architect.
 - 4. Minimum free area shall be 39% of nominal size.
 - 5. Based on Ruskin Manufacturing, Co. BV100 or Greenheck Model BVF.

2.3 MATERIALS FOR LOUVERS

- A. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), alloy 6063-T5 or T-52.
- B. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producer for required finish.
- C. Aluminum Castings: ASTM B 26/B 26M, alloy 319.
- D. Stainless-Steel Sheet: ASTM A 666, Type 304, with No. 4 finish.
- E. Fasteners: Of same basic metal and alloy as fastened metal or 300 Series stainless steel, unless otherwise indicated. Do not use metals that are incompatible with joined materials.
 - 1. Use types and sizes to suit unit installation conditions.
 - 2. Use Phillips flat-head, hex-head, or Phillips pan-head screws for exposed fasteners, unless otherwise indicated.
- F. Post installed Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, made from stainless-steel components, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load imposed, for masonry, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
- G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.4 FABRICATION, GENERAL FOR LOUVERS

- A. Assemble louvers in factory to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- B. Vertical Assemblies: Where height of louver units exceeds fabrication and handling limitations, fabricate units to permit field-bolted assembly with close-fitting joints in jambs and mullions, reinforced with splice plates.
- C. Continuous Vertical Assemblies: Fabricate units without interrupting blade-spacing pattern.
- D. Maintain equal louver blade spacing to produce uniform appearance.
- E. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
- F. Frame Type: As indicated.
- G. Include supports, anchorages, and accessories required for complete assembly.

- H. Provide vertical mullions of type and at spacings indicated, but not more than recommended by manufacturer, or 72 inches o.c., whichever is less.
- I. Provide subsills or extended sills made of same material as louvers where indicated or required for drainage to exterior and to prevent water penetrating to interior.
- J. Provide with optional wire mesh filter rack and filters.
- K. Join frame members to each other and to fixed louver blades with fillet welds, threaded fasteners, or both, as standard with louver manufacturer, concealed from view, unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

2.5 LOUVER SCREENS

- A. General: Provide screen at each exterior louver.
 - 1. Screen Location for Fixed Louvers: Interior face.
 - 2. Screening Type: Insect screening, unless otherwise indicated; bird screening where indicated.
- B. Secure screens to louver frames with stainless-steel machine screws, spaced a maximum of 6 inches from each corner and at 12 inches o.c.
- C. Louver Screen Frames: Fabricate with mitered corners to louver sizes indicated.
 - 1. Metal: Same kind and form of metal as indicated for louver to which screens are attached. Reinforce extruded-aluminum screen frames at corners with clips.
 - 2. Finish: Same finish as louver frames to which louver screens are attached.
 - 3. Type: Rewireable frames with a driven spline or insert for securing screen mesh.
- D. Louver Screening for Aluminum Louvers:
 - 1. Insect Screening: Aluminum, 18 x 16 inch mesh, 0.012 inch wire.
 - 2. Bird Screening: Aluminum, 1/2 inch square mesh, 0.063 inch wire.

2.6 CLOSURE ANGLES AND CLOSURE PLATES FOR LOUVERS

- A. Fabricate from minimum 0.074 inch thick stainless steel or aluminum.
- B. Provide continuous closure angles and closure plates on inside head, jambs, and sill of exterior wall louvers.
- C. Secure angles and plates to louver frames with screws, and to masonry or concrete with fasteners as specified.
- D. Provide minimum 0.032 inch thick stainless steel or aluminum sleeves in cavity walls and elsewhere as shown.

2.7 BLANK-OFF PANELS

- A. Uninsulated, Blank-Off Panels:
 - 1. Aluminum sheet for aluminum louvers, not less than 0.05 inch nominal thickness, unless otherwise indicated.
 - 2. Panel Finish: Same finish applied to louvers.
 - 3. Attach blank-off panels to back of louver frames with clips or stainless-steel, sheet metal screws.
- B. Insulated, Blank-off Panels: Laminated metal-faced panels consisting of insulating core surfaced on back and front with Metal sheets:
 - 1. Thickness: 2 inches.
 - 2. Metal Facing Sheets: Aluminum sheet, not less than 0.032 inch nominal thickness.
 - 3. Insulating Core: Foamed-plastic rigid insulation board.

4. Edge Treatment: Trim perimeter edges of blank-off panels with louver manufacturers standard extruded-aluminum-channel frames, not less than 0.080 inch nominal thickness, with corners mitered and with same finish as panels.
5. Seal perimeter joints between panel faces and louver frames with 1/8 x 1 inch PVC compression gaskets.
6. Panel Finish: Same finish applied to louvers.
7. Attach blank-off panels to back of louver frames with clips or stainless steel, sheet metal screws.

2.8 ALUMINUM FINISHES

- A. Finish louvers after assembly.
- B. High-Performance Organic Finish: 2-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers written instructions.
 1. Color and Gloss: As selected by School Board from manufacturers full range if not indicated as part of the Design Build Package.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

- A. Install all products in strict accordance with the manufacturer's written installation instructions.
- B. Coordinate the installation of products provided within other sections of Division 23 including but not limited to control dampers, airflow measuring stations, etc.

3.2 INSTALLATION

- A. Duct Access Doors:
 1. Coordinate the proper class access door with the system requirements.
 2. Duct access doors shall be mounted so as to allow maximum access and/or door swing while also providing easy access from the floor or other personal accessible structures.
 3. Duct access doors shall be provided wherever required for proper maintenance of equipment, access to duct mounted control devices, or visual inspection and setting of dampers, etc. All doors, due to the small scale of the drawings, may not be shown, it is the contractor's responsibility to coordinate with all trades concerned to provide the necessary quantity and properly locate all doors.
- B. Fire Doors:
 1. Fire doors shall be provided where indicated.
 2. Review the architectural drawings to determine the wall construction rating so as to provide the proper rated damper.
 3. All fire doors shall be mounted within a 16-gauge steel sleeve permanently affixed to the wall by means of perimeter retaining angles.
 4. The fire door shall be permanently attached to the sleeve. All voids around the sleeve and damper and sleeve and wall shall be properly fire stopped under Division 7 Section "Firestopping."
 5. Ductwork shall be attached to the fire door by means of a UL approved break away connection.
 6. Access doors or access sections shall be provided at all fire door locations.

C. Fire Dampers:

1. Fire dampers shall be provided where indicated.
2. Review the architectural drawings to determine the wall construction rating so as to provide the proper rated damper.
3. All fire dampers shall be mounted within a UL approved thickness galvanized steel sleeve permanently affixed to the wall by means of perimeter retaining angles.
4. The fire damper shall be permanently attached to the sleeve. All voids around the sleeve and damper and sleeve and wall shall be properly fire stopped under Division 7 Section "Firestopping."
5. Ductwork shall be attached to the fire damper by means of a UL approved break away connection.
6. Access doors or access sections shall be provided at all fire damper locations.

D. Smoke Dampers:

1. Provided where indicated. See combination smoke/fire damper for assemblies in fire rated barriers.
2. Review the architectural drawings to determine the wall construction rating so as to provide the proper rated damper.
3. Provide access doors or access sections at all damper locations.
4. Coordinate the provision of the smoke damper actuator with the automatic temperature control and fire alarm system and ensure adequate space for the mounting of the actuator during installation of the damper and ductwork.

E. Smoke/Fire Damper:

1. Provided where indicated. All smoke dampers in fire rated barriers to be combination type.
2. Review the architectural drawings to determine the wall construction rating so as to provide the proper rated damper.
3. All smoke/fire dampers shall be mounted within a UL approved thickness galvanized steel sleeve permanently affixed to the wall by means of perimeter retaining angles.
4. The smoke/fire damper shall be permanently attached to the sleeve. All voids around the sleeve and damper and sleeve and wall shall be properly fire stopped under Division 7 Section "Firestopping."
5. Ductwork shall be attached to the smoke/fire damper by means of a UL approved break away connection.
6. Access doors or access sections shall be provided at all smoke/fire damper locations.
7. Coordinate the provision of the smoke damper actuator with the Building Control System and assure adequate space for the mounting of the actuator during installation of the smoke/fire damper and ductwork.

F. Backdraft Damper:

1. Securely attach backdraft damper to wall with a suitable sleeve and retaining angles and seal all voids between damper and wall.
2. Adjust damper to open or close under the design conditions.

G. Volume Dampers: Install at all branch take-offs.

H. Prefabricated Casing Panels:

1. Casing shall be constructed as detailed on drawings. All necessary structural steel bracing required but not shown shall be provided.

2. Casing shall be sealed airtight both positive and negative to 10 inch w.g.
 3. Install in accordance with SMACNA duct construction standards for the pressure indicated.
 4. Set access doors minimum 6 inches above floor as detailed on drawings. Arrange door swings so that fan static pressure holds door in closed position.
 5. In casing sections subject to collection of water, where deep seal traps are shown, coordinate with other trades to be certain that traps are properly located.
 6. All openings in casing shall be framed. All pipes shall be sleeved and area between pipe and sleeve sealed.
- I. Flexible Duct Connectors:
1. Flexible duct connectors shall not be omitted where air handling units are provided with internally isolated fans and internal isolation.
 2. Provide flexible duct connectors immediately adjacent to all in-line or ductwork connected fans and/or fan equipped units with or without internal vibration isolation.
 3. Flexible duct connectors shall be properly selected and installed to ensure against collapsing under negative pressure and unacceptable ballooning under positive pressure. Leakage is not permissible. See width schedule in 3.3 - Schedules.
- J. Roof Mounted Air Outlets and Inlets:
1. Install in accordance with manufacturers written installation instructions.
 2. Coordinate installation requirements with roofing sub-contractor.
- K. Hardware Cloth: Install over-all open-ended ducts. Provide sheet metal pocket over raw edges and secure with sheet metal screws through the metal edge cover.
- L. Aluminum Brick Vent: Receive an unload louver and deliver to general contractor at jobsite for storage and installation by general contractor.
- M. Install Miscellaneous Control Devices:
1. Install dampers furnished under Section 23 09 00. Provide necessary blank off sections where dampers are installed in factory fabricated mixing box openings.
 2. Install air flow measuring stations furnished under Section 23 09 00. Coordinate size and location with proper access before approving release of units for fabrication and shipment.
 3. Install duct smoke detectors provided under Division 26.

3.3 INSTALLATION FOR LOUVERS

- A. Locate and place louvers level, plumb, and at indicated alignment with adjacent work and in accordance with manufacturer's recommendations to meet requirements of article titled "Performance Requirements".
- B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weather-tight connection.
- C. Form closely fitted joints with exposed connections accurately located and secured.
- D. Install closure angles and closure plates.
- E. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- F. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.
- G. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.

- H. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weather-tight louver joints are required. Comply with Division 7 Section "Joint Sealants" for sealants applied during louver installation.

3.4 ADJUSTING AND CLEANING FOR LOUVERS

- A. Clean exposed surfaces of louvers and vents that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate until final cleaning.
- B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.
- C. Restore louvers and vents damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.

3.5 SCHEDULES

- A. Access Door Schedule: Square or Rectangular Duct work: Access Door Mounting

Surface Max. Dim.	Access door Size
6"	12 inch long removable section
7" to 8"	6" x 6"
9" to 12" dia.	8 " x 8"
13" to 18" dia.	12" x 12"
19" and up	16" x 16"
Special Situations	See Plans

- B. Flexible Duct Connector Schedule: Indoor and Outdoor Material Width Schedule

Duct Size (Max Dim.)	Pressure (Max.)	Width
12" and less	positive	3"
13" and up	positive	6"
12" and less	negative	3"
13" and up	negative	3"

END OF SECTION

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