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PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Mechanical Contractor shall retain the services of a Building Automation System (BAS) manufacturer or subcontractor to perform the installation and integration of the BAS and equipment and to perform all other work associated with the HVAC Instrumentation and Controls. The Building Automation System (BAS) manufacturer or subcontractor shall be responsible for providing and installing a fully integrated building automation system, incorporating direct digital control (DDC) for energy management, equipment monitoring and control, and subsystems with open communications capabilities as specified, including sequence of operations, and points lists as specified.
- B. Work performed by the BAS installing contractor shall include but not be limited to the following:
 - 1. Furnish all controls equipment
 - 2. Complete installation and wiring of the controls system in accordance with project documents and manufacturers requirements.
 - 3. Point-to-point verification of all BAS system configurations, communications and I/O point wiring with witness by Owner's representatives
 - 4. On-site supervision, project management and coordination as required and as outlined in project documents
 - 5. All BAS system warranty and re-installation and re-commissioning of warranty repairs

1.02 RELATED WORK

- A. Division 010000 General and Special Conditions
- B. Division 230000 Heating, Ventilating and Air Conditioning
- C. Division 230993 Sequence of Operations
- D. Division 260000 Electrical
- E. Division 280000 Electronic Safety and Security
- F. Division 238129 VARIABLE REFRIGERANT FLOW HVAC SYSTEMS

1.03 SUBMITTALS

- A. Submit 5 complete sets of documentation in the following phased delivery schedule:
 - 1. System schematics, including:
 - a. sequence of operations
 - b. point names
 - c. point addresses
 - d. interface wiring diagrams
 - e. panel layouts
 - f. system riser diagrams
- B. Upon project completion, submit operation and maintenance manuals, consisting of the following:
 - 1. Index sheet, listing contents in alphabetical order

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2. Manufacturer's equipment parts list of all functional components of the system
3. Auto-CAD disk of system schematics, including wiring diagrams
4. Description of sequence of operations
5. As-Built interconnection wiring diagrams

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Honeywell. Siemens, Johnson Controls

PART 3 - EXECUTION

3.01 SEQUENCE OF OPERATION

- A. All DDC points shall be available for monitoring and command. Install new DDC controls in accordance with the attached sequence of operations and as indicated on the project drawings. All thermostats shall be installed as indicated on the project plans, wireless thermostats may be utilized if battery life is 4-years or longer.
- B. Global HVAC Characteristics determined with agreement from Owner's Representatives. The BAS contractor with assistance from the consulting engineer shall obtain the following operational information and incorporate these settings into the BAS.
1. Time-of-day scheduling for each area
 2. Occupied and un-occupied area temperature set-points.
 3. Alarm limits and alarm set-points
 4. Equipment scheduling

Indoor Unit Sequence of Operation – Cooling Mode

Indoor unit may be controlled by the built-in return air thermistor, wireless remote controller, or wired wall controller. This sequence of operation is based on using a wired wall controller

The wall controller senses room temperature and signals the indoor unit to turn on cooling, when cooling mode is selected. The following sequence occurs within the indoor unit:

First Step

- When wall controller mode is switched to cooling, indoor unit (IDU) fan will turn on to low speed

Second Step

- Wall controller senses room temperature has risen +1°F above cooling setpoint
- IDU signals outdoor unit and /or heat recovery unit that cooling is required
- IDU fan turns on to customer selected fan speed

Third Step

- IDU fan speed decreases to low fan speed when room temperature falls 1°F below setpoint temperature.

Indoor Unit Sequence of Operation – Heating Mode

Indoor unit is controlled by the built-in return air thermistor, wireless remote controller, or wired wall controller. This sequence of operation is based on using a wired wall controller.

The wall controller senses room temperature and signals the indoor unit to turn on heat, when heat mode is selected. The following sequence occurs within the indoor unit:

1. Indoor unit (IDU) fan is off
2. Wall controller senses room temperature has fallen below heating setpoint (72°F assumed for this example) and signals IDU heat is required
3. Outdoor unit turns on in heat mode
4. IDU fan turns on to low speed after IDU pipe temperature reaches hotstart off temperature (72°F for ducted indoor units)
5. IDU fan speed increases to customer selected fan speed when IDU pipe temperature reaches setting temperature (80°F for ducted indoor units)
6. IDU fan speed drops to low speed when IDU pipe temperature drops below low temperature setting (76°F for ducted indoor units) due to airflow across the IDU coil
7. IDU fan speed increases to customer selected fan speed when IDU pipe temperature rises above setting temperature (80°F for ducted indoor units)
8. Wall controller will signal IDU to turn off heat when room temperature reaches heating setpoint +3°C (77°F for this example).
9. IDU fan speed decreases to low speed
10. IDU fan turns off after IDU pipe temperature falls below low temperature setting (76°F for ducted indoor units)

Unit Heaters and Cabinet Unit heaters

Local unit mounted thermostat shall enable the fan and open the HW control valve to maintain local set-point. The controls shall be electric or electronic self-contained type. Local thermostat shall cycle fan to maintain room set-point. An aqua-stat shall be installed to stop fan cycling when hot water is available.

Outdoor Air Pre-conditioner – ER-1 through ER- 4

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The outdoor are pre-conditioners are configured with intake and exhaust fans with variable frequency drives, intake and exhaust filters, enthalpy wheel, intake and exhaust dampers and on-board manufacturers furnished controls for enthalpy wheel operation. This unit shall be controlled and monitored by a local DDC controller and the BAS shall communicate via Modbus or BACnet open protocol with the ER unit controller. Control points can be integrated into the BAS via open protocols (software) or hardwired via separate sensors, wiring and controls.

The Operation of the unit shall be interlocked with the initiation occupied modes of operation of any equipment and areas served by the unit. When indexed to the occupied mode the dampers shall open, the fans shall be enabled on and the enthalpy wheel shall operate. The Supply and exhaust/return fan VFDs shall be controlled by the BAS to maintain duct static pressure set-points as measured by duct static pressure sensors located 2/3 downstream in both the supply and exhaust/return duct. The static pressure sensors will respond to the opening and closing of the individual Fan Coil fresh air and exhaust air dampers as the units are indexed to the occupied and un-occupied modes of operation. Outdoor air intake measurement shall be included in the BAS if the manufacturers furnished ERV air flow station accommodates an auxiliary signal for BAS monitoring.

When no downstream HVAC equipment served by the ERV is in the occupied mode – the ERV will be indexed into the un-occupied mode in accordance with the units on-board controls.

Smoke dampers located in the supply and exhaust ducts shall remain open unless smoke is sensed by a local duct smoke detector located in the duct near the dampers. The FCU controller shall monitor the closed status of the smoke damper via end switch provided with smoke damper. Smoke damper and Smoke detector status may be by software integration with building fire alarm system.

Safety

Smoke detectors in the supply and return air streams de-energize the supply and return fans upon activation. A smoke detector alarm shall be initiated in the BAS operator interface.

A low temperature detector in the supply air stream shall send a signal to the downstream HVAC units served by the ERV when temperatures below 38 degrees F (3 degrees C) are sensed. A freeze-protection alarm shall be initiated in the BAS operator interface. And the ERV shall be indexed-off into the un-occupied mode

Alarm condition in the heat wheel control shall be monitored in the BAS and shall generate an alarm if status deviates from wheel enable command.

Point Description	Point Type
Low Temperature detection thermostat – Supply air-stream	DI
Supply airstream duct temperature	AI
Outdoor air intake (shared point-software) Temperature	AI
Outdoor air flow measurement	AI
Enable Energy Wheel operation	DO

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Energy wheel alarm	DI
Return/Exhaust air filter - alarm	DI
Outside air filter - alarm	DI
Return/Exhaust fan VFD Start/Stop	DO
Return/Exhaust fan VFD Control	AO
Return/Exhaust fan VFD Alarm	DI
Return/Exhaust fan VFD Feedback	AI
Return/Exhaust fan Status	DI
Return/Exhaust smoke detector (software point)	DI
Supply fan VFD Start/Stop	DO
Supply fan VFD Control	AO
Supply fan VFD Alarm	DI
Supply fan VFD Feedback	AI
Supply fan VFD Status	DI
Supply smoke detector (software point)	DI
Dirty filter alarms (2)	DI(2)
Supply Duct – Downstream duct Static pressure	AI
Return/Exhaust Duct – Downstream duct Static pressure	AI
Duct Smoke Detector alarm	DI
Duct Smoke damper open status	DI

Exhaust Fans

All exhaust fans shall be controlled on a time-if-day basis by the BAS. The exhaust fan running status shall be monitored through the BAS with a current sensor relay.

There shall be a local override switch located in the kitchen area shall override the time-of-day schedule for the Kitchen exhaust fans for an operator programmable period of time. The kitchen exhaust fans are enabled-on the respective FCU that served that are shall be indexed into the occupied mode.

Point Description	Point Type
Exhaust Fans Start-stop (Typical of all fans)	DO
Exhaust Fans Status – via current sensing relay (Typical of all fans)	DI
Kitchen Exhaust Fans –Exhaust Damper motor interlock	DO/Interlock
Kitchen Exhaust Fans running status	DI
Kitchen Exhaust Fan Start/stop override	DO

Mechanical Equipment and Electrical Equipment room Ventilation

The BAS shall provide CO, Combustible Gas sensors for each respective Mechanical room. The sensors shall be located as indicated on the project plans.

The exhaust fans that serve these areas shall be cycled on at low speed to maintain a maximum room temperature of 85 def F (adjustable).

When alarm limits are reached for these sensors the respective purge, ventilation and exhaust fans shall be enabled-on at High Speed operation and a local audible and visual alarm shall be energized and alarm shall generate on the graphical workstation. Any dampers inline with the purge, ventilation and exhaust fans shall be proofed open prior to fan start. The MER exhaust fans shall remain enable-on at high speed until the sensor alarm limits are no longer exceeded.

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Point Description	Point Type
Mechanical Room CO Sensor (Quantity as indicated on drawings)	AI
Mechanical Room Combustible gas sensors (Qty-4 minimum or additional as indicated on drawings)	AI (4)
Boiler room audible and visual alarm	DO

Miscellaneous BAS Alarm Points and Monitoring

1. The BAS shall monitor the normal and switched status of each ATS switch, if provisions for monitoring are available in gear.
2. The BAS shall monitor the operation and status of the Generator. The BAS shall monitor up to (12) points if available through the Generator control panel controller.
3. The BAS shall monitor the Tele/Data Room AC units' status and alarms if available through the Manufacturers controller. The BAS shall install monitor a representative room temperature sensor for each Tele/Data Room.
4. The BAS shall monitor both the 110 Deg F and 140 Deg F domestic HW services via well type temperature sensors furnished by the BAS contractor and installed by the mechanical contractor..
5. The BAS shall monitor and alarm the temperatures in refrigerated Food storage facilities in 1st floor kitchen area. A door contact shall be provided for each walk-in refrigerator and shall signal an alarm in the BAS if open for an extended period of time. Initially the alarm period will be set for 15 minutes.

3.02 COMMISSIONING, TESTING AND ACCEPTANCE

- A. Perform a three-phase commissioning procedure consisting of field I/O commissioning, system commissioning and integrated system program commissioning. Document all commissioning information on commissioning data sheets which shall be submitted prior to acceptance testing. Commissioning work which requires shutdown of system or deviation from normal function shall be performed when the operation of the system is not required. The commissioning must be coordinated with the owner and construction manager to ensure systems are available when needed. Notify the operating personal in writing of the testing schedule so that authorized personnel from the owner and construction manager are present throughout the commissioning procedure.
- B. After the above tests are complete and the system is demonstrated to be functioning as specified, a thirty-day performance test period shall begin. If the system performs as specified throughout the test period, requiring only routine maintenance, the system shall be accepted. If the system fails during the test, and cannot be fully corrected within eight hours, the owner may request that performance tests be repeated.

3.03 TRAINING

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- A. The manufacturer shall provide factory-trained instructor to give full instruction to designated personnel in the operation of the system installed. Instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach. The manufacturer shall provide all students with a student binder containing product specific training modules for the system installed. All training shall be held during normal working hours of 8:00 am to 4:30 PM weekdays.

- B. Provide 16 hours of training for Owner's designated operating personnel. Training shall include:

Explanation of drawings, operations and maintenance manuals
Walk-through of the job to locate control components
Operator workstation and peripherals
DDC controller and ASC operation/function
Operator control functions including graphic generation and field panel programming
Operation of portable operator's terminal
Explanation of adjustment, calibration and replacement procedures
Student binder with training modules

- C. Since the Owner may require personnel to have more comprehensive understanding of the hardware and software, additional training must be available from the Manufacturer. If such training is required by the Owner, it will be contracted at a later date.

END OF SECTION