Part 1 General

1.1 SECTION INCLUDES

.1 Air supply system

.2 Thermostats.

.3 Humidistats.

.4 Control valves.

.5 Dampers Motorized

.6 Damper operators.

.7 Blinds Interface

.8 Time clocks.

.9 Miscellaneous accessories.

1.2 REFERENCES

.1 AMCA 500 - Test Methods for Louvres, Dampers and Shutters.

.2 ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

.3 ASTM B32 - Solder Metal.

.4 ASTM B280 - Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.

.5 ASTM D1693 - Environmental Stress - Cracking of Ethylene Plastics.

.6 NEMA DC 3 - Residential Controls - Electric Wall-Mounted Room Thermostats.

.7 NFPA 90A - Installation of Air Conditioning and Ventilation Systems.

1.3 SUBMITTALS FOR REVIEW

.1 Section 21 05 00: Procedures for submittals.

.2 Product Data: Provide description and engineering data for each control system component. Include sizing as requested. Provide data for each system component and software module.

.3 Shop Drawings: Indicate complete operating data, system drawings, wiring diagrams, and written detailed operational description of sequences. Submit schedule of valves indicating size, flow, and pressure drop for each valve. For automatic dampers indicate arrangement, velocities, and static pressure drops for each system.

1.4 SUBMITTALS FOR INFORMATION

.1 Section 21 05 00: Submittals for information.

.2 Manufacturer's Instructions: Provide for all manufactured components.

1.5 SUBMITTALS AT PROJECT CLOSEOUT

.1 Section 21 05 00: Submittals for project closeout.

.2 Project Record Documents: Record actual locations of control components, including panels, thermostats, and sensors. Accurately record actual location of control components, including panels, thermostats, and sensors.

.3 Revise shop drawings to reflect actual installation and operating sequences.

.4 Operation and Maintenance Data: Include inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.

.5 Warranty: Submit manufacturer’s warranty and ensure forms have been filled out in The Citys name and registered with manufacturer.

1.6 QUALITY ASSURANCE

.1 The Installer shall have an established working relationship with the Control System Manufacturer, and be the authorized representative of the Manufacturer at bid time.

.2 The Installer shall have successfully completed Control System Manufacturer's classes on the control system. The Installer shall present for review the certification of completed training, including the hours of instruction and course outlines upon request.

.3 All products used in this installation shall be new, currently under manufacture, and shall be applied in standard off-the-shelf products. This installation shall not be used as a test site for any new products unless explicitly approved by the Contract Administrator in writing. Spare parts shall be available for at least 5 years after completion of this contract.

1.7 REGULATORY REQUIREMENTS

.1 All work, materials, and equipment shall comply with the rules and regulations of all codes and ordinances of the local, provincial, and national authorities. Such codes, when more restrictive, shall take precedence over these plans and specifications. As a minimum, the installation shall comply with the current editions in effect 30 days prior to receipt of bids of the following codes:

.1 Canadian Electric Code (CEC)
.2 National Building Code (NBC)
.3 ASHRAE 135
.4 Underwriters Laboratories UL916

1.8 WARRANTY

.1 Section 21 05 00: Submittals for project closeout.

.2 Labor and materials for the control system specified shall be warranted free from defects for a period of 12 months after final completion and acceptance. Control system failures during the warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to the The City. The Mechanical subcontractor shall respond to the The City's request for warranty service within 24 hours during normal business hours.

.3 All work shall have a single warranty date, even when the The City has received beneficial use due to an early system start-up. If the work specified is split into multiple contracts or a multi-phase contract, then each contract or phase shall have a separate warranty start date and period

.4 Operator workstation software, project-specific software, graphic software, database software, and firmware updates which resolve known software deficiencies as identified by the Mechanical subcontractor shall be provided at no charge during the warranty period. Any upgrades or functional enhancements associated with the above mentioned items also can be provided during the warranty period for an additional charge to the The City by purchasing an in-warrant technical support agreement from the Mechanical subcontractor. Written authorization by the The City must, however, be granted prior to the installation of any of the above-mentioned items.

.5 Exception: The Mechanical subcontractor shall not be required to warrant reused devices, except for those that have been rebuilt and/or repaired. The Mechanical subcontractor shall warrant all installation labour and materials, however, and shall demonstrate that all reused devices are in operable condition at the time of Contract Administrator review.

1.9 MAINTENANCE SERVICE

.1 Section 21 05 00: Submittals for project closeout.

.2 Provide service and maintenance of control system from Date of Substantial Completion.

.3 Provide complete service of controls systems, including call backs. Make minimum of two complete normal inspections of approximately four (4) hours duration in addition to normal service calls to inspect, calibrate, and adjust controls, and submit written reports.

1.10 SYSTEM AND COMPONENT PERFORMANCE

.1 Performance Standards. System shall conform to the following minimum standards over network connections. Systems shall be tested using manufacturer's recommended hardware and software for operator workstation (server and browser for web-based systems).

.2 Graphic Display. A graphic with 20 dynamic points shall display with current data within 10 sec.

.3 Graphic Refresh. A graphic with 20 dynamic points shall update with current data within 8 sec. and shall automatically refresh every 15 sec.

.4 Configuration and Tuning Screens. Screens used for configuring, calibrating, or tuning points, PID loops, and similar control logic shall automatically refresh within 6 sec.

.5 Object Command. Devices shall react to command of a binary object within 2 sec. Devices shall begin reacting to command of an analog object within 2 sec.

.6 Alarm Response Time. The maximum time from when an object goes into alarm to when it is annunciated at the workstation shall not exceed 45 seconds

.7 Object Scan. All changes of state and change of analog values will be transmitted over the high-speed Ethernet network such that any data used or displayed at a controller or workstation will have been current within the previous 2 seconds

.8 Performance. Programmable controllers shall be able to completely execute DDC PID control loops at a frequency adjustable down to once per sec. Select execution times consistent with the mechanical process under control.

.9 Reporting Accuracy. System shall report values with minimum end-to-end accuracy listed in Table 1.

.10 Control Stability and Accuracy. Control loops shall maintain measured variable at setpoint within tolerances listed in Table 2.

Table 1
Reporting Accuracy

Measured Variable	**Reported Accuracy**
Space Temperature	±0.5ºC (±1ºF)
Ducted Air	±0.5ºC (±1ºF)
Outside Air	±1.0ºC (±2ºF)
Dew Point	±1.5ºC (±3ºF)
Water Temperature	±0.5ºC (±1ºF)
Delta-T	±0.15ºC (±0.25ºF)
Relative Humidity	±5% RH
Airflow (terminal)	±10% of full scale (see Note 1)
Airflow (measuring stations)	±5% of full scale
Airflow (pressurized spaces)	±3% of full scale
Air Pressure (ducts)	±25 Pa (±0.1 in. w.g.)
Air Pressure (space)	±3 Pa (±0.01 in. w.g.)
Water Pressure	±2% of full scale (see Note 2)
Carbon Dioxide (CO_2)	±30 ppm

Table 2
Control Stability and Accuracy

Controlled Variable	**Control Accuracy**	**Range of Medium**
Air Pressure	±50 Pa (±0.2 in. w.g.) ±3 Pa (±0.01 in. w.g.)	0-1.5 kPa (0-6 in. w.g.) -25 to 25 Pa (-0.1 to 0.1 in. w.g.)
Airflow	±10% of full scale	
Space Temperature	±1.0ºC (±2.0ºF)	
Duct Temperature	±1.5ºC (±3ºF)	

Humidity	±5% RH	
Fluid Pressure	±10 kPa (±1.5 psi) ±250 Pa (±1.0 in. w.g.)	MPa (1-150 psi) 0-12.5 kPa (0-50 in. w.g.) differential

Part 2 Products

2.1 CARBON DIOXIDE SENSOR

.1 Acceptable manufacturers.

.1 DCS Airsense

.2 Substitutions: Refer to Section 21 05 00.

.2 Non-dispersive infrared (NDIR), Diffusion with a Measurement Range 0-2000 ppm

.1 Repeatability ± 20 ppm CO2 Measurement Accuracy ± 30 ppm ± 2% of reading,

.2 Power Requirements 18 - 30 VDC or 18 - 28 Vrms AC

.3 Operating Temperature Range 0 - 50 0C

.4 Operating Humidity Range 0 - 99% RH, non-condensing

.5 Voltage Output (linear) 0 - 10 VDC full-scale standard

.6 Optional Current Output (linear) 4-20 mA RLOOP < 600 Ω

.7 Dimensions 4.5 x 2.8 x 0.9 inches

.3 Model 308 – Wall or Duct Mount – No display

.4 Model 350 – Wall or Duct Mount – With display

2.2 CONTROL PANELS

.1 Unitized cabinet type for each system under automatic control with relays and controls mounted in cabinet and temperature indicators, pressure gauges, pilot lights, push buttons and switches flush on cabinet panel face.

.2 NEMA 250, general purpose utility enclosures with enamelled finished face panel.

.3 Provide common keying for all panels.

2.3 CONTROL VALVES

.1 Acceptable manufacturers.

.1 Belimo

.2 Siemens

.3 Honeywell

.4 Schneider Electric

.5 Johnson Controls

.6 Substitutions: Refer to Section 21 05 00.

.2 Ball Valves:

.1 Bronze body, Stainless Steel trim, 2 or 3 port as indicated, replaceable plugs and seats, union and threaded ends.

.2 Rate for service pressure exceeding 860 kPa at 121 degrees C (125 psig at 250 degrees F).

.3 Two way valves with equal percentage characteristics, three way valves with linear characteristics. Size two way valve operators to close valves against pump shut off head.

.3 Butterfly Pattern:

.1 Body: Cast or ductile iron with resilient replaceable EPDM seat, wafer or lug ends, extended neck.

.2 Disc: Stainless Steel.

.3 Hydronic Systems:

.1 Rate for service pressure of 860 kPa at 121 degrees C (125 psig at 250 degrees F).

.2 Refer to schedule for maximum pressure drop at design flow rate.

.4 Valve Operators:

.1 General: Provide smooth proportional control with sufficient power for full shut off at maximum pump differential pressure or maximum head pressure development from the pump, elevation and system pressure.

.2 Spring return to normal position as indicated on freeze, fire, or temperature protection.

.3 Number: Sufficient to achieve unrestricted movement throughout actuation range.

.4 Operators (2 Position): Synchronous motor with enclosed gear train, dual return springs, valve position indicator; 24 v DC. Valves: spring return to normal position for temperature protection.

.5 Operators (Modulating): Self contained, linear motorized actuator with approximately 19 mm(3/4 inch) stroke, 60 second full travel with transformer and SPDT contacts: 24 v DC, Valves: spring return to normal position for temperature protection..

2.1 DAMPERS - MOTORIZED

.1 Tamco Model 1500 or 9000 SC (Insulated).

.2 Other Acceptable Manufacturers:

.1 Alumavent

.2 Substitutions: Refer to Section 21 05 00.

.3 Performance: Test to AMCA 500.

.4 Frames: Extruded aluminum, welded or riveted with corner reinforcement, minimum 2.0 mm (0.081 inch) thick. Damper frame is 100mm (4 inch) deep.

.5 All dampers for duct sizes with a dimension (either width or height) 300 mm (12 inches) or less shall be flanged to the duct. In-duct frames not allowed.

.6 Blades: Extruded aluminum air foil profile, maximum blade size 150 mm (6 inches) wide, maximum blade length section 1200 mm (48 inches).

.7 Insulation : Internally insulated with expanded polyurethane foam and are thermally broken. Complete blade has an insulating factor of R-2.29 and a temperature index of 55.

.8 Blade Seals: Extruded silicone mechanically attached, field replaceable.

.9 Frame/Jamb Seals: Extruded silicone mechanically attached, field replaceable.

.10 Bearings: Celcon inner bearing fixed to a 7/16" (11.11 mm) aluminum hexagon blade pivot pin, rotating within a polycarbonate outer bearing inserted in the frame,

.11 Linkage: Installed in frame side and constructed of aluminum and corrosion-resistant, zinc-plated steel, complete with cup-point trunnion screws for a slip-proof grip.

.12 Leakage: Class 1A at 0.25 kPa (1 in. w.g.) static pressure differential. Class 1 at 1 kPa (4 in. w.g.) static pressure differential. Standard air leakage data is certified under the AMCA Certified Ratings Program.

.13 Maximum blade length Static Pressure: 1.0 kPa (4 inches wg)

.14 Temperature Limits: -40 to 100 degrees C (-40 to 212 degrees F).

2.2 DAMPER OPERATORS

.1 General: Provide smooth proportional control with sufficient power for air velocities 20 percent greater than maximum design velocity and to provide tight seal against maximum system pressures. Provide spring return for two position control and for fail safe operation.

.2 Electric Operators:

.3 Acceptable manufacturers.

.1 Belimo
.2 Siemens
.3 Honeywell
.4 Schneider Electric
.5 Johnson Controls

.4 Substitutions: Refer to Section 21 05 00.

.5 Spring return, adjustable stroke motor having oil immersed gear train, with auxiliary end switch minimum position potentiometer

.6 Number: Sufficient to achieve unrestricted movement throughout damper range.

2.3 BLIND INTERFACE (Provided by Architectural)

.1 Acceptable manufacturers.

.1 Somfy - Model Animeo IP Building Controller

.1 Substitutions: Refer to Section 21 05 00.

.2 Features

.1 Sun tracking for dynamic facade control
.2 Sensor threshold based motor control
.3 Accurate time & astronomic motor control
.4 Network-based motor control with user account access
.5 Integration with third party control systems and BMS Systems
.6 System auto discovery of motors, sensors, keypads
.7 IP connectivity for Sub Controller connections, virtual keypads, remote access and programming
.8 Windows 7-based drag-and-drop setup, configuration & operation

.3 Accessories

.1 Additional Sub-Controllers
.2 Bus Power Supply(s)
.3 Power panel(s)
.4 Compact sensor (indoor/Outdoor)

2.4 HUMIDISTATS

.1 Limit Duct Humidistat:

.1 Insertion, two position type.
.2 Throttling range: Adjustable 2 percent relative humidity.
.3 Operating range: 20 to 80 percent.
.4 Maximum temperature: 65 degrees C (150 degrees F).

2.5 INPUT/OUTPUT SENSORS

.1 Temperature:

.1 Resistance temperature detectors with resistance tolerance of plus or minus 0.1 percent at 21 degrees C (70 degrees F), interchangeability less than plus or minus 0.2 percent, time constant of 13 seconds maximum for fluids and 200 seconds maximum for air.
.2 Measuring current maximum 5 mA with maximum self-heat of 0.017 degrees C/mW(0.031 degrees F/mW) in fluids and 0.008 degrees C/mW(0.014 degrees F/mW) in air.
.3 Provide 3 lead wires and shield for input bridge circuit.
.4 Use insertion elements in ducts not affected by temperature stratification or smaller than one square metre. Use averaging elements where larger or prone to stratification sensor length 2.5 m(8 feet) or 5 m(16 feet) as required.
.5 Insertion elements for liquids: with brass socket, minimum insertion length of 60 mm(2-1/2 inches).
.6 Room sensors: Locking cover.
.7 Outside air sensors: Watertight inlet fitting, shielded from direct rays of sun.

.8 Room security sensors: Stainless steel cover plate with insulated back and security screws.

.2 Humidity Sensors:

.1 Elements: Accurate within 5 percent full range with linear output.

.2 Room Sensors: With locking cover, span of 10 to 80 percent relative humidity

.3 Duct and Outside Air Sensors: With element guard and mounting plate, range of 0 100 percent relative humidity.

.3 Static Pressure Sensors:

.1 Unidirectional with ranges not exceeding 150 percent of maximum expected input.

.2 Temperature compensate with typical thermal error or 0.06 percent of full scale in temperature range of 5 to 40 degrees C (40 to 100 degrees F).

.3 Accuracy: One percent of full scale with repeatability 0.3 percent.

.4 Output: 0 - 5 vdc with power at 12 to 28 vdc.

.4 Equipment Operation Sensors:

.1 Status Inputs for Fans: Differential pressure switch with adjustable range of 0 to 1250 Pa (0 to 5 inches wg).

.2 Status Inputs for Pumps: Differential pressure switch piped across pump with adjustable pressure differential range of 50 to 400 kPa (8 to 60 psi).

.3 Status Inputs for Electric Motors: Current sensing relay with current transformers, adjustable and set to 175 percent of rated motor current.

.5 Damper Position Indication: Potentiometer mounted in enclosure with adjustable crank arm assembly connected to damper to transmit 0 - 100 percent damper travel.

2.6 THERMOSTATS (DDC)

.1 Digital combination Thermostats (Commercial):

.1 Digital display (Confirm Locations)

.2 Humidity Sensing (where indicated)

.3 CO2 Sensing (where indicated)

.2 Outdoor Reset Thermostat:

.1 Remote bulb or bimetal rod and tube type, proportioning action with adjustable throttling range, adjustable set point.

.2 Scale range: -23 to 56 degrees C (-10 to 70 degrees F).

.3 Immersion Thermostat:

.1 Remote bulb or bimetallic rod and tube type, proportional action with adjustable set point and adjustable throttling range.

.4 Airstream Thermostats:

.1 Remote bulb or bimetallic rod and tube type, proportional action with adjustable set-point in middle of range and adjustable throttling range.

.2 Averaging service remote bulb element: 2.3 m(7.5 feet).

.5 Electric Low Limit Duct Thermostat (Freeze Stat):

.1 Snap acting, single pole, single throw, manual reset switch which trips if temperature sensed across any 300 mm(12 inches) of bulb length is equal to or below set point,

.2 Provide one thermostat for every 1.86 sq m(20 sq ft) of coil surface.

.6 Electric High Limit Duct Thermostat:

.1 Snap acting, single pole, single throw, automatic reset switch which trips if temperature sensed across any 300 mm(12 inches) of bulb length is equal to or above set point,

.2 Provide one thermostat for every 1.86 sq m(20 sq ft) of coil surface.

2.7 TIME CLOCKS

.1 Seven day programming switch timer with synchronous timing motor and seven day dial, continuously charged Ni-cad battery driven power failure 8 hour carry over and multiple switch trippers to control systems for minimum of two and maximum of eight signals per day with two normally open and two normally closed output switches.

.2 Solid state programmable time control with multiple separate programs, 24 hour battery carry over duty cycling, individual on/off/auto switches for each program, 7 day programming, 365 day calendar with 20 programmable holidays choice of fail safe operation for each program, system fault alarm.

2.8 TRANSMITTERS

.1 Building Static Pressure Transmitter:

.1 One pipe, differential type with temperature compensation, scale range 2.5 to 1500 kPa (0.01 to 6.0 inch wg) positive or negative, and sensitivity of 0.125 kPa (0.0005 inch wg). Transmit electronic pneumatic signal to receiver with matching scale range.

.2 Pressure Transmitters:

.1 One pipe direct acting for gas, liquid, or steam service, range suitable for system, proportional electronic output.

.3 Temperature Transmitters:

.1 One pipe, directly proportional output signal to measured variable, linearity within plus or minus 1/2 percent of range for 93 degrees C (200 degree F) span and plus or minus 1 percent for 10 degrees C (50 degree F) span, with 10 degree C (50 degrees F) temperature range, compensated bulb, averaging capillary, or rod and tube operation on 138 kPa (20 psig) input pressure and 20 to 100 kPa (3 to 15 psig) output.

.4 Humidity Transmitters:

.1 One pipe, directly proportioned output signal to measured variable, linearity within plus or minus 1 percent for 70 percent relative humidity span, capable of withstanding 95 percent relative humidity without loss of calibration.

2.9 RELAYS.

.1 Control Relays. Control relays shall be plug-in type, ULC/CSA listed, and shall have dust cover and LED "energized" indicator. Contact rating, configuration, and coil voltage shall be suitable for application.

.2 Time Delay Relays. Time delay relays shall be solid-state plug-in type, UL listed, and shall have adjustable time delay. Delay shall be adjustable ±100% from setpoint shown. Contact rating, configuration, and coil voltage shall be suitable for application. Provide NEMA 1 enclosure for relays not installed in local control panel.

2.10 CURRENT TRANSFORMERS.

.1 AC current transformers shall be UL/CSA recognized and shall be completely encased (except for terminals) in approved plastic material.

.2 Transformers shall be available in various current ratios and shall be selected for ±1% accuracy at 5 A full-scale output.

.3 Use fixed-core transformers for new wiring installation and split-core transformers for existing wiring installation.

2.11 VOLTAGE TRANSFORMERS.

.1 AC voltage transformers shall be UL/CSA recognized, 600 Vac rated, and shall have built-in fuse protection.

.2 Transformers shall be suitable for ambient temperatures of 4°C-55°C (40°F-130°F) and shall provide ±0.5% accuracy at 24 Vac and 5 VA load.

.3 Windings (except for terminals) shall be completely enclosed with metal or plastic.

2.12 CURRENT SWITCHES.

.1 Current-operated switches shall be self-powered, solid-state with adjustable trip current. Select switches to match application current and DDC system output requirements.

Part 3 Execution

3.1 EXAMINATION

.1 Section 21 05 00: Verification of existing conditions before starting work.

.2 Verify that systems are ready to receive work.

.3 Beginning of installation means installer accepts existing conditions.

.4 Sequence work to ensure installation of components is complementary to installation of similar components in other systems.

.5 Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.

.6 Ensure installation components are complementary to installation of similar components.

.7 Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.

.8 The Mechanical subcontractor shall examine the drawings and specifications for other parts of the work. If head room or space conditions appear inadequate — or if any discrepancies occur between the plans and the Mechanical subcontractor's work, and the plans and the work of others — the Mechanical subcontractor shall report these discrepancies to the Contract Administrator and shall obtain written instructions for any changes necessary to accommodate the Mechanical subcontractor's work with the work of others. Any changes in the work covered by this specification made necessary by the failure or neglect of the Mechanical subcontractor to report such discrepancies shall be made by — and at the expense of — this Mechanical subcontractor.

3.2 INSTALLATION

.1 Install to manufacturers written instructions.

.2 Check and verify location of thermostats, humidistats, and CO2 Detectors and other exposed control sensors with plans and room details before installation. Align with lighting switches and humidistats.

.3 Mount freeze protection thermostats using flanges and element holders.

.4 Mount outdoor reset thermostats and outdoor sensors indoors, with sensing elements outdoors with sun and wind shield.

.5 Provide separable sockets for liquids and flanges for air bulb elements. Refer to Section 23 05 19.

.6 Provide guards or password protection on thermostats in entrances and other public areas.

.7 Provide LCD thermostats in offices, meeting room, where occupant control is required.

.8 Provide valves with position indicators and with pilot positioners where sequenced with other controls.

.9 Provide isolation (two position) dampers of parallel blade construction.

.10 Provide control (modulating position) dampers of opposed blade construction.

.11 Install damper motors on outside of duct in warm areas. Do not install motors in locations at outdoor temperatures.

.12 Coordinate location of the differential pressure sensor as shown on the drawings. If not shown on the drawings locate the pressure sensor at the furthest and most flow demanding pipe branch in the system. Show location on shop drawings and on GUI.

.13 Mount control panels adjacent to associated equipment on vibration free walls or free standing angle iron supports. One cabinet may accommodate more than one system in

same equipment room. Provide engraved plastic nameplates for instruments and controls inside cabinet and engraved plastic nameplates on cabinet face.

.14 Install "hand/off/auto" selector switches to override automatic interlock controls when switch is in "hand" position.

.15 Provide data connection to the blind controller connection, coordinate location.

.16 Provide conduit and electrical wiring to Section 26 05 80. Electrical material and installation to appropriate requirements of Division 16.

3.3 MANUFACTURER'S FIELD SERVICES

.1 Section 21 05 00: Prepare and start systems.

.2 Start and commission systems. Allow sufficient time for start-up and commissioning prior to placing control systems in permanent operation.

3.4 DEMONSTRATION AND INSTRUCTIONS

.1 Section 21 05 00: Demonstrating installed work.

.2 Demonstrate complete and operating system to The City.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Control equipment.

.2 Software.

1.2 REFERENCES

.1 NEMA EMC1 - Energy Management Systems Definitions.

.2 NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

.3 NFPA 90A - Installation of Air Conditioning and Ventilation Systems.

.4 ASHRAE Standard 135-2012 -- BACnet®--A Data Communication Protocol for Building Automation and Control Networks

1.3 SYSTEM DESCRIPTION

.1 Automatic temperature control field monitoring and control system using field programmable micro-processor based units with communications to Building Management System specified in Section 25 30 00.

.2 Base system on distributed system of fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment on token passing network, with central and remote hardware, software, and interconnecting wire and conduit.

.3 Include computer software and hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.

.4 Controls for variable air volume terminals, radiation, reheat coils, unit heaters, fan coils, and the like when directly connected to the control units. Individual terminal unit control is specified in Section 23 36 00.

.5 Provide control systems consisting of thermostats, control valves, dampers and operators, indicating devices, interface equipment and other apparatus and accessories required to operate mechanical systems, and to perform functions specified.

.6 Include installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.

1.4 SUBMITTALS FOR REVIEW

.1 Section 21 05 00: Procedures for submittals.

.2 Product Data: Provide data for each system component and software module.

.3 Shop Drawings:

.1 Indicate trunk cable schematic showing programmable control unit locations, and trunk data conductors.

.2 List connected data points, including connected control unit and input device.

.3 Indicate system graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations.

.4 Show system configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.

.5 Indicate description and sequence of operation of operating, user, and application software.

1.5 SUBMITTALS FOR INFORMATION

.1 Section 21 05 00: Submittals for information.

.2 Manufacturer's Instructions: Indicate manufacturer's installation instructions for all manufactured components.

1.6 SUBMITTALS AT PROJECT CLOSEOUT

.1 Section 21 05 00: Submittals for project closeout.

.2 Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors.

.1 Revise shop drawings to reflect actual installation and operating sequences.

.2 Include data specified in "Submittals" in final "Record Documents" form.

.3 Operation and Maintenance Data:

.1 Include interconnection wiring diagrams complete field installed systems with identified and numbered, system components and devices.

.2 Include keyboard illustrations and step-by-step procedures indexed for each operator function.

.3 Include inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.

.4 Warranty: Submit manufacturers warranty and ensure forms have been filled out in The Citys name and registered with manufacturer.

1.7 QUALITY ASSURANCE

.1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented install experience.

.2 Installer Qualifications: Company specializing in performing the work of this section with documented experience and approved by manufacturer.

.3 Design system software under direct supervision of a Professional Engineer experienced in design of this Work and licensed in the Province or Territory where the Project is located.

1.8 REGULATORY REQUIREMENTS

.1 Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.9 WARRANTY

.1 Section 21 05 00: Submittals for project closeout.

.2 Correct defective Work within one year period after Substantial Completion.

.3 Provide five year manufacturer's warranty for field programmable micro-processor based units.

1.10 MAINTENANCE SERVICE

.1 Section 21 05 00: Submittals for project closeout.

.2 Provide service and maintenance of energy management and control systems for one years from Date of Substantial Completion.

.3 Provide four complete inspections per year, one in each season, to inspect, calibrate, and adjust controls as required, and submit written reports.

.4 Provide complete service of systems, including call backs.

1.11 EXTRA MATERIALS

.1 Section 21 05 00: Submittals for project closeout.

1.12 PROTECTION OF SOFTWARE RIGHTS

.1 Prior to delivery of software, the The City and the party providing the software will enter into a software license agreement with provisions for the following:

.1 Limiting use of software to equipment provided under these specifications.
.2 Limiting copying.
.3 Preserving confidentiality.
.4 Prohibiting transfer to a third party.

Part 2 Products

2.1 APPROVED AGENCIES

.1 Johnson Controls - Metasys

2.2 OPERATOR STATION

.1 All workstations shall be new. The requirements below are a minimum standard.

.2 Work Station: Minimum Requirements

.1 Configuration: PC with Intel iCore based microcomputer system or better.

.2 Minimum memory: 4 Gb RAM.

.3 Display: (22 inch) LED monitor

.4 Keyboard: Low profile, detachable, having Qwerty layout plus a 10 key numeric keypad, dedicated function keys.

.5 CD/DVD Drive:

.6 USB 2.0 & 3.0: Minimum two in front, two in back

.7 Hard disk drive: 500 Gb.

.8 Mouse: Software supported mouse with support software including self building menus and displays of system operations and functions.

.9 Network: Internal type 1000 Mbps

.10 Modem: Internal type modem or proprietary data modem with cables and communication interfaces required to provide the specified functions, minimum 56,000 bps rate.

.11 Printer: Support colour printer.

.12 Operating System: Windows 7 or later.

.3 Printer:

.1 Ink jet type, colour, capable of printing portrait or landscape, A3(11 x 17 inch) maximum paper size.

.2 Paper: Minimum 50 sheets.

.4 System Support: Minimum ten (10) work stations connected to multi-user, multi-tasking environment with concurrent capability to:

.1 Access DDC network.

.2 Access or control same control unit.

.3 Access or modify same control unit data base.

.4 Archive data, alarms, and network actions to hard disk regardless of what application programs are being currently executed.

.5 Develop and edit data base.

.6 Implement and tune DDC control.

.7 Develop graphics.

.8 Control facility.

2.3 CONTROL UNITS

.1 Units: Modular in design and consisting of processor board with programmable RAM memory, local operator access and display panel, and integral interface equipment.

.2 Battery Backup: For minimum of 48 hours for complete system including RAM without interruption, with automatic battery charger.

.3 Control Units Functions:

.1 Monitor or control each input/output point.

.2 Completely independent with hardware clock/calendar and software to maintain control independently.

.3 Acquire, process, and transfer information to operator station or other control units on network.

.4 Accept, process, and execute commands from other control unit's or devices or operator stations.

.5 Access both data base and control functions simultaneously.

.6 Record, evaluate, and report changes of state or value that occur among associated points. Continue to perform associated control functions regardless of status of network.

.7 Perform in stand-alone mode:

.1 Start/stop.

.2 Duty cycling.

.3 Automatic Temperature Control.

.4 Demand control via a sliding window, predictive algorithm.

.5 Event initiated control.

.6 Calculated point.

.7 Scanning and alarm processing.

.8 Full direct digital control.

.9 Trend logging.

.10 Global communications.

.11 Maintenance scheduling.

.4 Data Communication Protocol

.1 BACnet

.5 Global Communications:

.1 Broadcast point data onto network, making that information available to all other system control units.

.2 Transmit any or all input/output points onto network for use by other control units and utilize data from other control units.

.6 Input/Output Capability:

.1 Discrete/digital input (contact status).

.2 Discrete/digital output.

.3 Analog input.

.4 Analog output.

.5 Pulse input (5 pulses/second).

.6 Pulse output (0-655 seconds in duration with 0.01 second resolution).

.7 Monitor, control, or address data points. Include analog inputs, analog outputs, pulse inputs, pulse outputs and discrete inputs/outputs, as required. Install control unit's with minimum 30 percent spare capacity.

.8 Point Scanning: Set scan or execution speed of each point to operator selected time from 1 to 250 seconds.

.9 Upload/Download Capability: Download from or upload to operator station. Upload/Download time for entire control unit database maximum 10 seconds on hard wired LAN, or 60 seconds over voice grade phone lines.

.10 Test Mode Operation: Place input/output points in test mode to allow testing and developing of control algorithms on line without disrupting field hardware and controlled environment. In test mode:

.1 Inhibit scanning and calculation of input points. Issue manual control to input points (set analog or digital input point to operator determined test value) from work station.

.2 Control output points but change only data base state or value; leave external field hardware unchanged.

.3 (1) Enable control actions on output points but change only data base state or value.

.11 Local display and adjustment panel: Portable control unit, containing digital display, and numerical keyboard. Display and adjust:

.1 Input/output point information and status.

.2 Controller set points.

.3 Controller tuning constants.

.4 Program execution times.

.5 High and low limit values.

.6 Limit differential.

.7 Set/display date and time.

.8 Control outputs connected to the network.

.9 Automatic control outputs.

.10 Perform control unit diagnostic testing.

.11 Points in "Test" mode.

2.4 LOCAL AREA NETWORKS (LAN):

.1 Provide communication between control units over local area network (LAN).

.2 LAN Capacity: Not less than the require stations or nodes to complete the installation.

.3 Break in Communication Path: Alarm and automatically initiate LAN reconfiguration.

.4 LAN Data Speed: Minimum 1000 Mbps.

.5 Communication Techniques: Allow interface into network by multiple operation stations and by auto-answer/auto-dial modems. Support communication over telephone lines utilizing modems.

.6 Transmission Median Ethernet Cat 6 or single pair of solid 24 gauge twisted, shielded copper cable(MS/TP).

.1 MS/TP

.1 Daisy chain maximum, 20 nodes/controls

.2 Baud Rate: Minimum of 57600 bps

.7 Network Support: Less than 3 seconds for global point to be received by any station. Automatically reconfigure if any station is added or lost. If transmission cable is cut, reconfigure two sections with no disruption to system's operation, without operator intervention.

2.5 OPERATING SYSTEM SOFTWARE

.1 Input/Output Capability From Operator Station:

.1 Request display of current values or status in tabular or graphic format.

.2 Command selected equipment to specified state.

.3 Initiate logs and reports.

.4 Change analog limits.

.5 Add, delete, or change points within each control unit or application routine.

.6 Change point input/output descriptors, status, alarm descriptors, and engineering unit descriptors.

.7 Add new control units to system.

.8 Modify and set up maintenance scheduling parameters.

.9 Develop, modify, delete or display full range of colour graphic displays.

.10 Automatically archive select data even when running third party software.

.11 Provide capability to sort and extract data from archived files and to generate custom reports.

.12 Support two printer operations.

.1 Alarm printer: Print alarms, operator acknowledgements, action messages, system alarms, operator sign-on and sign-off.

.2 Data printer: Print reports, page prints, and data base prints.

.13 Select daily, weekly or monthly as scheduled frequency to synchronize time and date in digital control units. Accommodate daylight savings time adjustments.

.14 Print selected control unit data base.

.2 Operator System Access: Via software password with minimum 30 access levels at work station and minimum 3 access levels at each control unit.

.3 Data Base Creation and Support: Use standard procedures for changes. Automatically check work station data base files upon connection and verify data base match. Minimum capability:

.1 Add and delete points.

.2 Modify any point parameter.

.3 Change, add, or delete English language descriptors.

.4 Add, modify, or delete alarm limits.

.5 Add, modify, or delete points in start/stop programs, trend logs, etc.

.6 Create custom relationship between points.

.7 Create or modify DDC loops and parameters.

.8 Create or modify override parameters.

.9 Add, modify, and delete any applications program.

.10 Add, delete, develop, or modify dynamic colour graphic displays.

.4 Dynamic Colour Graphic Displays:

.1 Utilizes custom symbols or system supported library of symbols.

.2 Sixteen (16) colours.

.3 Sixty (60) outputs of real time, live dynamic data per graphic.

.4 Dynamic graphic data.

.5 1,000 separate graphic pages.

.6 Modify graphic screen refresh rate between 1 and 60 seconds.

.5 Operator Station:

.1 Accept data from LAN as needed without scanning entire network for updated point data.

.2 Interrogate LAN for updated point data when requested.

.3 Allow operator command of devices.

.4 Allow operator to place specific control units in or out of service.

.5 Allow parameter editing of control units.

.6 Store duplicate data base for every control unit and allow down loading while system is on line.

.7 Control or modify specific programs.

.8 Develop, store and modify dynamic colour graphics.

.9 Provide data archiving of assigned points and support overlay graphing of this data utilizing up to four (4) variables.

.6 Alarm Processing:

.1 Off normal condition: Cause alarm and appropriate message, including time, system, point descriptor, and alarm condition. Select alarm state/value and determine which alarms cause automatic dial-out.

.2 Critical alarm or change-of-state: Display message, stored on disk for review and sort, or print.

.3 Print on line changeable message, up to 60 characters minimum in length, for each alarm point specified.

.4 Display alarm reports on video. Display multiple alarms in order of occurrence.

.5 Define time delay for equipment start-up or shutdown.

.6 Allow unique routing of specific alarms.

.7 Operator specifies if alarm requires acknowledgement.

.8 Continue to indicate unacknowledged alarms after return to normal.

.9 Alarm notification:

.1 Automatic print.

.2 Display indicating alarm condition.

.3 Selectable audible alarm indication.

.7 Event Processing: Automatically initiate commands, user defined messages, take specific control actions or change control strategy and application programs resulting from event condition. Event condition may be value crossing operator defined limit, change-of-state, specified state, or alarm occurrence or return to normal.

.8 Automatic Restart: Automatically restart field equipment on restoration of power. Provide time delay between individual equipment restart and time of day start/stop.

.9 Messages:

.1 Automatically display or print user-defined message subsequent to occurrence of selected events.

.2 Compose, change, or delete any message.

.3 Display or log any message at any time.

.4 Assign any message to any event.

.10 Reports:

.1 Manually requested with time and date.

.2 Long term data archiving to hard disk.

.3 Automatic directives to download to transportable media such as floppy diskettes for storage.

.4 Data selection methods to include data base search and manipulation.

.5 Data extraction with mathematical manipulation.

.6 Allow development of XY curve plotting, tabular reports (both statistical and summary), and multi-point timed based plots with not less than four (4) variables displayed.

.7 Generating reports either normally at operator direction, or automatically under work station direction.

.8 Reports may either manually displayed or printed, or may be printed automatically on daily, weekly, monthly, yearly or scheduled basis.

.9 Include capability for statistical data manipulation and extraction.

.10 Provide capability to generate four types of reports: Statistical detail reports, summary reports, trend graphic plots, x-y graphic plots.

.11 Parameter Save/Restore: Store most current operating system, parameter changes, and modifications on disk or diskette.

.12 Data Collection:

.1 Automatically collect and store in disk files.

.2 Daily electrical energy consumption, peak demand, and time of peak demand for up to 30 electrical meters over 2 year period.

.3 Daily consumption for up to 30 meters over a 2 year period.

.4 Daily billable electrical energy consumption and time for up to 1024 zones over a 10 year period.

.5 Provide archiving of stored data for use with system supplied custom reports.

.13 Graphic Display: Support graphic development on work station with software features:

.1 Page linking.

.2 Generate, store, and retrieve library symbols.

.3 Single or double height characters.

.4 Sixty (60) dynamic points of data per graphic page.

.5 Pixel level resolution.

.6 Animated graphics for discrete points.

.7 Analog bar graphs.

.8 Display real time value of each input or output line diagram fashion.

.14 Maintenance Management:

.1 Run time monitoring, per point.

.2 Maintenance scheduling targets with automatic annunciation, scheduling and shutdown.

.3 Equipment safety targets.

.4 Display of maintenance material and estimated labour.

.5 Target point reset, per point.

.15 Advisories:

.1 Summary which contains status of points in locked out condition.

.2 Continuous operational or not operational report of interrogation of system hardware and programmable control units for failure.

.3 Report of power failure detection, time and date.

.4 Report of communication failure with operator device, field interface unit, point, programmable control unit.

2.6 LOAD CONTROL PROGRAMS

.1 General: Support inch-pounds and S.I. metric units of measurement.

.2 Duty Cycling:

.1 Periodically stop and start loads, based on space temperature, and according to various On/Off patterns.

.2 Modify off portion of cycle based on operator specified comfort parameters. Maintain total cycle time by increasing on portion of cycle by same amount that off portion is reduced.

.3 Set and modify following parameters for each individual load.

.1 Minimum and maximum Off time.

.2 On/Off time in one minute increments.

.3 Time period from beginning of interval until load can be cycled.

.4 Manually override the DCC program and place a load in an On or Off state.

.5 Cooling Target Temperature and Differential.

.6 Heating Target Temperature and Differential.

.7 Cycle off adjustment.

.3 Automatic Time Scheduling:

.1 Self-contained programs for automatic start/stop/scheduling of building loads.

.2 Support up to seven (7) normal day schedules, seven (7) "special day" schedules and two (2) temporary day schedules.

.3 Provide capacity for 30 unique date/duration special days schedule.

.4 Any number of loads assigned to any time program; each load can have individual time program.

.5 Each load assigned at least 16 control actions per day with 1 minute resolution.

.6 Time schedule operations may be:

.1 Start.

.2 Optimized Start.

.3 Stop.

.4 Optimized Stop.

.5 Cycle.

.6 Optimized Cycle.

.7 Minimum of 30 holiday periods up to 100 days in length may be specified for the year.

.8 Create temporary schedules.

.9 Broadcast temporary "special day" date and duration.

.4 Start/Stop Time Optimization:

.1 Perform optimized start/stop as function of outside conditions, inside conditions, or both.

.2 Adaptive and self-tuning, adjusting to changing conditions unattended.

.3 For each point under control, establish and modify:

.1 Occupancy period.

.2 Desired temperature at beginning of occupancy period.

.3 Desired temperature at end of occupancy period.

.5 Night Setback/Setup Program: Reduce heating space temperature set point or raise cooling space temperature set point during unoccupied hours; in conjunction with scheduled start/stop and optimum start/stop programs.

.6 Calculated Points: Define calculations and totalization computed from monitored points (analog/digital points), constants, or other calculated points.

.1 Employ arithmetic, algebraic, Boolean, and special function operations.

.2 Treat calculated values like any other analog value, use for any function that a "hard wired point" might be used.

.7 Event Initiated Programming: Event may be initiated by any data point, causing series of controls in a sequence.

.1 Define time interval between each control action between 0 to 3600 seconds.

.2 Output may be analog value.

.3 Provide for "skip" logic.

.4 Verify completion of one action before proceeding to next. If not verified, skip to next action.

.8 Direct Digital Control: Provide each control unit with Direct Digital Control software so that the operator may customize control strategies and sequences of operation by defining the appropriate control loop algorithms and choosing the optimum loop parameters.

.1 Control loops: Defined using "modules" that are analogous to standard control devices.

.2 Output: Paired or individual digital outputs for pulse-width modulation, and analog outputs, as required.

.3 Firmware:

.1 PID with analog or pulse-width modulation output.

.2 Floating control with pulse-width modulated outputs.

.3 Two-position control.

.4 Primary and secondary reset schedule selector.

.5 Hi/Lo signal selector.

.6 Single pole double throw relay.

.7 Single pole double throw time delay relay with delay before break, delay before make and interval time capabilities.

.4 Direct Digital Control loops: Downloaded upon creation or on operator request. On sensor failure, execute user defined failsafe output.

.5 Display: Value or state of each of the lines which interconnect DDC modules.

.9 Fine Tuning Direct Digital Control PID or floating loops:

.1 Display information:

.1 Control loop being tuned

.2 Input (process) variable

.3 Output (control) variable

.4 Set point of loop

.5 Proportional band

.6 Integral (reset) Interval

.7 Derivative (rate) Interval

.2 Display format: Graphic, with automatic scaling; with input and output variable superimposed on graph of "time" vs "variable".

.10 Trend logging:

.1 Each control unit will store samples of control unit's data points.

.2 Update file continuously at discretely assignable intervals.

.3 Automatically initiate upload request and then store data on hard disk.

.4 Time synchronize sampling at operator specified times and intervals with sample resolution of one minute.

.5 Co-ordinate sampling with on/off state of specified point.

.6 Display trend samples on work station in graphic format. Automatically scale trend graph with minimum 60 samples of data in plot of time vs data.

2.7 HVAC CONTROL PROGRAMS

.1 General:

.1 Support Inch-pounds and S.I. metric units of measurement.

.2 Identify each HVAC Control system.

.2 Optimal Run Time:

.1 Control start-up and shutdown times of HVAC equipment for both heating and cooling.

.2 Base on occupancy schedules, outside air temperature, seasonal requirements, and interior room mass temperature.

.3 Start-up systems by using outside air temperature, room mass temperatures, and adaptive model prediction for how long building takes to warm up or cool down under different conditions.

.4 Use outside air temperature to determine early shut down with ventilation override.

.5 Analyze multiple building mass sensors to determine seasonal mode and worse case condition for each day.

.6 Operator commands:

.1 Define term schedule

.2 Add/delete fan status point.

.3 Add/delete outside air temperature point.

.4 Add/delete mass temperature point.

.5 Define heating/cooling parameters.

.6 Define mass sensor heating/cooling parameters.

.7 Lock/unlock program.

.8 Request optimal run time control summary.

.9 Request optimal run time mass temperature summary.

.10 Request HVAC point summary.

.11 Request HVAC saving profile summary.

.7 Control Summary:

.1 HVAC Control system begin/end status.

.2 Optimal run time lock/unlock control status.

.3 Heating/cooling mode status.

.4 Optimal run time schedule.

.5 Start/Stop times.

.6 Selected mass temperature point ID.

.7 Optimal run time system normal start times.

.8 Occupancy and vacancy times.

.9 Optimal run time system heating/cooling mode parameters.

.8 Mass temperature summary:

.1 Mass temperature point type and ID.

.2 Desired and current mass temperature values.

.3 Calculated warm-up/cool-down time for each mass temperature.

.4 Heating/cooling season limits.

.5 Break point temperature for cooling mode analysis.

.9 HVAC point summary:

.1 Control system identifier and status.

.2 Point ID and status.

.3 Outside air temperature point ID and status.

.4 Mass temperature point ID and status.

.5 Calculated optimal start and stop times.

.6 Period start.

.3 Supply Air Reset:

.1 Monitor heating and cooling loads in building spaces, terminal reheat systems, both hot deck and cold deck temperatures on dual duct and multizone systems, single zone unit discharge temperatures.

.2 Adjust discharge temperatures to most energy efficient levels satisfying measured load by:

.1 Raising cooling temperatures to highest possible value.

.2 Reducing heating temperatures to lowest possible level.

.3 Operator commands:

.1 Add/delete fan status point.

.2 Lock/unlock program.

.3 Request HVAC point summary.

.4 Add/Delete discharge controller point.

.5 Define discharge controller parameters.

.6 Add/delete air flow rate.

.7 Define space load and load parameters.

.8 Request space load summary.

.4 Control summary:

.1 HVAC control system status (begin/end).

.2 Supply air reset system status.

.3 Optimal run time system status.

.4 Heating and cooling loop.

.5 High/low limits.

.6 Deadband.

.7 Response timer.

.8 Reset times.

.5 Space load summary:

.1 HVAC system status.

.2 Optimal run time status.

.3 Heating/cooling loop status.

.4 Space load point ID.

.5 Current space load point value.

.6 Control heat/cool limited.

.7 Gain factor.

.8 Calculated reset values.

.9 Fan status point ID and status.

.10 Control discharge temperature point ID and status.

.11 Space load point ID and status.

.12 Air flow rate point ID and status.

.4 Enthalpy Switch over:

.1 Calculate outside and return air enthalpy using measured temperature and relative humidity; determine energy expended and control outside and return air dampers.

.2 Operator commands:

.1 Add/delete fan status point.

.2 Add/delete outside air temperature point.

.3 Add/delete discharge controller point.

.4 Define discharge controller parameters.

.5 Add/delete return air temperature point.

.6 Add/delete outside air dewpoint/humidity point.

.7 Add/delete return air dewpoint/humidity point.

.8 Add/delete damper switch.

.9 Add/delete minimum outside air.

.10 Add/delete atmospheric pressure.

.11 Add/delete heating override switch.

.12 Add/delete evaporative cooling switch.

.13 Add/delete air flow rate.

.14 Define enthalpy deadband.

.15 Lock/unlock program.

.16 Request control summary.

.17 Request HVAC point summary.

.3 Control summary:

.1 HVAC control system begin/end status.

.2 Enthalpy switch over optimal system status.

.3 Optimal return time system status.

.4 Current outside air enthalpy.

.5 Calculated mixed air enthalpy.

.6 Calculated cooling cool enthalpy using outside air.

.7 Calculated cooling cool enthalpy using mixed air.

.8 Calculated enthalpy difference.

.9 Enthalpy switch over deadband.

.10 Status of damper mode switch.

.5 Energy Monitoring (Electrical, Air and Hydronic)

.1 Airside energy measurements are calculated in the DDC system using air temperature and flow rate measurements.

.2 Waterside energy is to be calculated in the DDC system using fluid entering and leaving temperature and known constant flow rate measurements.

2.8 PROGRAMMING APPLICATION FEATURES

.1 Trend Point:

.1 Sample points, real or computed, with each point capable of collecting samples at intervals specified in minutes, hours, days, or month.

.2 Output trend logs as line graphs or bar graphs. Output graphic on terminal, with each point for line and bar graphs designated with a unique pattern and colour, vertical scale either actual values or percent of range, and horizontal scale time base. Print trend logs up to 12 columns of one point/column.

.2 Alarm Messages:

.1 Allow definition messages.

.1 All objects that must be alarmed will have in the alarm message text the following information as per the included example.

.2 Alarm Message: Building Address, What is in alarm, see graphic for Instruction

.2 Assign alarm messages to system messages including point's alarm condition, point's off-normal condition, totalized point's warning limit, hardware elements advisories.

.3 Output assigned alarm with "message requiring acknowledgement".

.4 Operator commands include define, modify, or delete; output summary listing current alarms and assignments; output summary defining assigned points.

.3 Weekly Scheduling:

.1 Automatically initiate equipment or system commands, based on preselected time schedule for points specified.

.2 Provide program times for each day of week, per point, with one minute resolution.

.3 Automatically generate alarm output for points not responding to command.

.4 Provide for holidays.

.5 Operator commands:

.1 System logs and summaries.

.2 Start of stop point.

.3 Lock or unlock control or alarm input.

.4 Add, delete, or modify analog limits and differentials.

.5 Adjust point operation position.

.6 Change point operational mode.

.7 Open or close point.

.8 Enable/disable, lock/unlock, or execute interlock sequence or computation profile.

.9 Begin or end point totalization.

.10 Modify totalization values and limits.

.11 Access or secure point.

.12 Begin or end HVAC or load control system.

.13 Modify load parameter.

.14 Modify demand limiting and duty cycle targets.

.6 Output summary: Listing of programmed function points, associated program times, and respective day of week programmed points by software groups or time of day.

.4 Interlocking:

.1 Permit events to occur, based on changing condition of one or more associated master points.

.2 Binary contact, high/low limit of analog point or computed point are capable of being utilized as master. Same master may monitor or command multiple slaves.

.3 Operator commands:

.1 Define single master/multiple master interlock process.

.2 Define logic interlock process.

.3 Lock/unlock program.

.4 Enable/disable interlock process.

.5 Execute terminate interlock process.

.6 Request interlock type summary.

Part 3 Execution

3.1 EXAMINATION

.1 Section 21 05 00: Verification of existing conditions before starting work.

.2 Verify that conditioned power supply is available to the control units and to the operator work station. Verify that field end devices, wiring, and pneumatic tubing is installed prior to installation proceeding.

3.2 INSTALLATION

.1 Install control units and other hardware in position on permanent walls where not subject to excessive vibration.

.2 Install software in control units and in operator work station. Implement all features of programs to specified requirements and appropriate to sequence of operation.

.3 Provide with 120v AC, 15 amp dedicated emergency power circuit to each programmable control unit.

.4 Provide conduit and electrical wiring to Section 26 05 80. Electrical material and installation to appropriate requirements of Division 26.

3.3 MANUFACTURER'S FIELD SERVICES

.1 Section 21 05 00: Prepare and start systems.

.2 Start and commission systems. Allow sufficient time for start-up and commissioning prior to placing control systems in permanent operation.

.3 Provide service engineer to instruct The City's representative in operation of systems plant and equipment. Provide sign off sheets; refer to section 21 05 00.

.4 Provide basic operator training for the operators on data display, alarm and status descriptors, requesting data, execution of commands and request of logs. Include dedicated instructor time, sufficient to meet the operator(s) requirements. Receive signoff from the operator(s) once complete. Provide training on site.

3.4 DEMONSTRATION AND INSTRUCTIONS

.1 Section 21 05 00: Demonstrating installed work.

.2 Demonstrate complete and operating system to The City.

END OF SECTION

PART 1-GENERAL

1.1 RELATED WORK

.1 The General Conditions and General Specifications form an integral part of this specification and must be read in conjunction herewith. Read also and be fully cognizant of all Mechanical Sections.

1.2 DESCRIPTION

.1 Refer to section 23 & 25 for further detail and scope of work.

.2 This specification is to cover a complete Adjustable Frequency motor Drive (AFD) consisting of a pulse width modulated (PWM) inverter designed for use on a standard NEMA Design B induction motor. It is required that the drive manufacturer have an existing:

- .1 Sales representative exclusively for HVAC products, with expertise in HVAC systems and controls.
- .2 An independent service organization.

.3 The drive manufacturer shall supply the drive and all necessary controls as herein specified. The manufacturer shall have been engaged in the production of this type of equipment for a minimum of twenty years.

.4 VFD harmonic mitigation equipment shall be included, as part of the integrated VFD package to meet the THD levels required in the section titled "Harmonic Distortion Requirements".

1.3 QUALITY ASSURANCE

.1 Referenced Standards:

- .1 Institute of Electrical and Electronic Engineers (IEEE)
  - .1 Standard 519-1992, IEEE Guide for Harmonic Content and Control.
- .2 Underwriters laboratories
  - .1 UL508C
- .3 National Electrical Manufacturer’s Association (NEMA)
  - .1 ICS 7.0, AC Adjustable Speed Drives
- .4 IEC 16800 Parts 1 and 2

.2 Qualifications:

- .1 AFDs and options shall be ULC listed as a complete assembly. AFD’s that require the customer to supply external fuses for the AFD to be ULC listed are not acceptable. The base AFD shall be ULC listed for 100 KAIC without the need for input fuses.
- .2 CE Mark – The AFD shall conform to the European Union ElectroMagnetic Compatibility directive, a requirement for CE marking. The AFD shall meet product standard EN 61800-3 for the First Environment restricted level.
- .3 Acceptable Manufactures
  - .1 ABB ACH 550 Series.
  - .2 Contract Administrator approved within 2 weeks of bid. Approval does not relieve supplier of specification requirements.
  - .3 AFDs that are manufactured by a third party and “brand labeled” shall not be acceptable.

.4 The AFD manufacturer shall have available a comprehensive, HVAC Drive Computer Based Training (CBT) product. The CBT product shall include detailed, interactive sections covering AFD unpacking, proper mechanical and electrical installation, and programming. The CBT product shall allow the user to provide just-in-time training to new personnel or refresher training for maintenance and repair personnel on the user's site. The CBT product shall be repeatable, precise and shall include record keeping capability. The CBT product shall record answers to simulations and tests by student ID. The CBT product must be professionally produced and have interactive sections, student tests, and include video clips of proper wiring and installation.

1.4 SUBMITTALS

.1 Submittals shall include the following information:

.1 Outline dimensions, conduit entry locations and weight.

.2 Customer connection and power wiring diagrams.

.3 Complete technical product description include a complete list of options provided

.4 Submit sample input current waveforms that are to be expected. This should include examples from previous installations with similar integrated harmonic mitigating equipment VFD packages. The data submitted shall meet the levels required in the "Harmonic Distortion Requirements" section.

.5 Compliance to IEEE 519 – harmonic analysis for particular jobsite including total harmonic voltage distortion and total harmonic current distortion (TDD).

.1 The AFD manufacturer shall provide calculations; specific to this installation, showing total harmonic voltage distortion is less than 5%. Input line filters shall be sized and provided as required by the AFD manufacturer to ensure compliance with IEEE standard 519. All AFD's shall include a minimum of 5% impedance reactors, no exceptions.

PRODUCTS

2.1 ADJUSTABLE FREQUENCY DRIVES

.1 The AFD package as specified herein shall be enclosed in a UL Listed enclosure, completely assembled and tested by the manufacturer in an ISO9001 facility. The AFD tolerated voltage window shall allow the AFD to operate from a line of +30% nominal, and -35% nominal voltage as a minimum.

.1 Environmental operating conditions: 0 to 40°C continuous. AFD's that can operate at 40° C intermittently (during a 24 hour period) are not acceptable and must be oversized. Altitude 0 to 3300 feet above sea level, less than 95% humidity, non-condensing.

.2 Enclosure shall be rated UL type 12 and shall be UL listed as a plenum rated AFD. AFD's without these ratings are not acceptable.

.2 All AFDs shall have the following standard features:

.1 All AFDs shall have the same customer interface, including digital display, and keypad, regardless of horsepower rating. The keypad shall be removable, capable of remote mounting and allow for uploading and downloading of parameter settings as an aid for start-up of multiple AFDs.

.2 The keypad shall include Hand-Off-Auto selections and manual speed control. The drive shall incorporate “bumpless transfer” of speed reference when switching between “Hand” and “Auto” modes. There shall be fault reset and “Help” buttons on the keypad. The Help button shall include “on-line” assistance for programming and troubleshooting.

.3 There shall be a built-in time clock in the AFD keypad. The clock shall have a battery back up with 10 years minimum life span. The clock shall be used to date and time stamp faults and record operating parameters at the time of fault. If the battery fails, the AFD shall automatically revert to hours of operation since initial power up. The clock shall also be programmable to control start/stop functions, constant speeds, PID parameter sets and output relays. The AFD shall have a digital input that allows an override to the time clock (when in the off mode) for a programmable time frame. There shall be four (4) separate, independent timer functions that have both weekday and weekend settings.

.4 The AFD’s shall utilize pre-programmed application macro’s specifically designed to facilitate start-up. The Application Macros shall provide one command to reprogram all parameters and customer interfaces for a particular application to reduce programming time. The AFD shall have two user macros to allow the end-user to create and save custom settings.

.5 The AFD shall have cooling fans that are designed for easy replacement. The fans shall be designed for replacement without requiring removing the AFD from the wall or removal of circuit boards. The AFD cooling fans shall operate only when required. To extend the fan and bearing operating life, operating temperature will be monitored and used to cycle the fans on and off as required.

.6 The AFD shall be capable of starting into a coasting load (forward or reverse) up to full speed and accelerate or decelerate to setpoint without safety tripping or component damage (flying start).

.7 The AFD shall have the ability to automatically restart after an over-current, over-voltage, under-voltage, or loss of input signal protective trip. The number of restart attempts, trial time, and time between attempts shall be programmable.

.8 The overload rating of the drive shall be 110% of its normal duty current rating for 1 minute every 10 minutes, 130% overload for 2 seconds. The minimum FLA rating shall meet or exceed the values in the NEC/UL table 430-150 for 4-pole motors.

.9 The AFD shall have an integral 5% impedance line reactors to reduce the harmonics to the power line and to add protection from AC line transients. The 5% impedance may be from dual (positive and negative DC bus) reactors, or 5% AC line reactors. AFD’s with only one DC reactor shall add AC line reactors.

.10 The input current rating of the AFD shall be no more than 3% greater than the output current rating. AFD’s with higher input current ratings

require the upstream wiring, protection devices and source transformers to be oversized per NEC 430-2.

.11 The AFD shall include a coordinated AC transient protection system consisting of 4-120 joule rated MOV's (phase to phase and phase to ground), a capacitor clamp, and 5% impedance reactors.

.12 The AFD shall be capable of sensing a loss of load (broken belt / broken coupling) and signal the loss of load condition. The drive shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus. Relay outputs shall include programmable time delays that will allow for drive acceleration from zero speed without signaling a false underload condition.

.13 If the input reference (4-20mA or 2-10V) is lost, the AFD shall give the user the option of either (1) stopping and displaying a fault, (2) running at a programmable preset speed, (3) hold the AFD speed based on the last good reference received, or (4) cause a warning to be issued, as selected by the user. The drive shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communication bus.

.14 The AFD shall have programmable "Sleep" and "Wake up" functions to allow the drive to be started and stopped from the level of a process feedback signal.

.3 All AFDs to have the following adjustments:

.1 Three (3) programmable critical frequency lockout ranges to prevent the AFD from operating the load continuously at an unstable speed.

.2 Two (2) PID Setpoint controllers shall be standard in the drive, allowing pressure or flow signals to be connected to the AFD, using the microprocessor in the AFD for the closed loop control. The AFD shall have 250 ma of 24 VDC auxiliary power and be capable of loop powering a transmitter supplied by others. The PID setpoint shall be adjustable from the AFD keypad, analog inputs, or over the communications bus. There shall be two parameter sets for the first PID that allow the sets to be switched via a digital input, serial communications or from the keypad for night setback, summer/winter setpoints, etc. There shall be an independent, second PID loop that can utilize the second analog input and modulate one of the analog outputs to maintain setpoint of an independent process (ie. valves, dampers, etc.). All setpoints, process variables, etc. to be accessible from the serial communication network. The setpoints shall be set in Engineering units and not require a percentage of the transducer input.

.3 Two (2) programmable analog inputs shall accept current or voltage signals.

.4 Two (2) programmable analog outputs (0-20ma or 4-20 ma). The outputs may be programmed to output proportional to Frequency, Motor Speed, Output Voltage, Output Current, Motor Torque, Motor Power (kW), DC Bus voltage, Active Reference, and other data.

.5 Six (6) programmable digital inputs for maximum flexibility in interfacing with external devices, typically programmed as follows:

.1 There shall be a run permissive circuit for damper or valve control. Regardless of the source of a run command (keypad, input contact closure, time-clock control, or serial

communications) the AFD shall provide a dry contact closure that will signal the damper to open (AFD motor does not operate). When the damper is fully open, a normally open dry contact (end-switch) shall close. The closed end-switch is wired to an AFD digital input and allows AFD motor operation. Two separate safety interlock inputs shall be provided. When either safety is opened, the motor shall be commanded to coast to stop, and the damper shall be commanded to close. The keypad shall display "start enable 1 (or 2) missing". The safety status shall also be transmitted over the serial communications bus. All digital inputs shall be programmable to initiate upon an application or removal of 24VDC.

.6 Three (3) programmable digital Form-C relay outputs. The relays shall include programmable on and off delay times and adjustable hysteresis. Default settings shall be for run, not faulted (fail safe), and run permissive. The relays shall be rated for maximum switching current 8 amps at 24 VDC and 0.4 A at 250 VAC; Maximum voltage 300 VDC and 250 VAC; continuous current rating 2 amps RMS. Outputs shall be true form C type contacts; open collector outputs are not acceptable.

.7 Seven (7) programmable preset speeds.

.8 Two independently adjustable accel and decel ramps with 1 – 1800 seconds adjustable time ramps.

.9 The AFD shall include a motor flux optimization circuit that will automatically reduce applied motor voltage to the motor to optimize energy consumption and audible motor noise.

.10 The AFD shall include a carrier frequency control circuit that reduces the carrier frequency based on actual AFD temperature that allows the highest carrier frequency without derating the AFD or operating at high carrier frequency only at low speeds.

.11 The AFD shall include password protection against parameter changes.

.4 The Keypad shall include a backlit LCD display. The display shall be in complete English words for programming and fault diagnostics (alpha-numeric codes are not acceptable). The keypad shall utilize the following assistants:

.1 Start-up assistants.

.2 Parameter assistants

.3 Maintenance assistant

.4 Troubleshooting assistant

.5 All applicable operating values shall be capable of being displayed in engineering (user) units. A minimum of three operating values from the list below shall be capable of being displayed at all times. The display shall be in complete English words (alpha-numeric codes are not acceptable):

.1 Output Frequency

.2 Motor Speed (RPM, %, or Engineering units)

.3 Motor Current

.4 Calculated Motor Torque

.5 Calculated Motor Power (kW)

.6 DC Bus Voltage

.7 Output Voltage

.6 The AFD shall include a fireman's override input. Upon receipt of a contact closure from the fireman's control station, the AFD shall operate at an adjustable

preset speed. The mode shall override all other inputs (analog/digital, serial communication, and all keypad commands) and force the motor to run at the adjustable, preset speed. "Override Mode" shall be displayed on the keypad. Upon removal of the override signal, the AFD shall resume normal operation.

.7 Serial Communications

.1 The AFD shall have an RS-485 port as standard. The standard protocols shall be Modbus, Johnson Controls N2 bus, and Siemens Building Technologies FLN. Optional protocols for LonWorks, BACnet, Profibus, Ethernet, and DeviceNet shall be available. Each individual drive shall have the protocol in the base AFD. The use of third party gateways and multiplexers is not acceptable. All protocols shall be "certified" by the governing authority. Use of non-certified protocols is not allowed.

.2 The BACnet connection shall be an RS485, MSTP interface operating at 9.6, 19.2, 38.4, or 76.8 Kbps. The connection shall be tested by the BACnet Testing Labs (BTL) and be BTL Listed. The BACnet interface shall conform to the BACnet standard device type of an Applications Specific Controller (B-ASC). The interface shall support all BIBBs defined by the BACnet standard profile for a B-ASC including, but not limited to:

.1 Data Sharing – Read Property – B.

.2 Data Sharing – Write Property – B.

.3 Device Management – Dynamic Device Binding (Who-Is; I-AM).

.4 Device Management – Dynamic Object Binding (Who-Has; I-Have).

.5 Device Management – Communication Control – B.

.3 If additional hardware is required to obtain the BACnet interface, the AFD manufacturer shall supply one BACnet gateway per drive. Multiple AFDs sharing one gateway shall not be acceptable.

.4 Serial communication capabilities shall include, but not be limited to; run-stop control, speed set adjustment, proportional/integral/derivative PID control adjustments, current limit, accel/decel time adjustments, and lock and unlock the keypad. The drive shall have the capability of allowing the DDC to monitor feedback such as process variable feedback, output speed / frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), and drive temperature. The DDC shall also be capable of monitoring the AFD relay output status, digital input status, and all analog input and analog output values. All diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote AFD fault reset shall be possible. The following additional status indications and settings shall be transmitted over the serial communications bus – keypad "Hand" or "Auto" selected, bypass selected, the ability to change the PID setpoint, and the ability to force the unit to bypass (if bypass is specified). The DDC system shall also be able to monitor if the motor is running in the AFD mode or bypass mode (if bypass is specified) over serial communications. A minimum of 15 field parameters shall be capable of being monitored.

.5 The AFD shall allow the DDC to control the drive's digital and analog outputs via the serial interface. This control shall be independent of any

AFD function. For example, the analog outputs may be used for modulating chilled water valves or cooling tower bypass valves. The drive's digital (relay) outputs may be used to actuate a damper, open a valve or control any other device that requires a maintained contact for operation. In addition, all of the drive's digital and analog inputs shall be capable of being monitored by the DDC system.

.6 The AFD shall include an independent PID loop for customer use. The independent PID loop may be used for cooling tower bypass value control, chilled water value control, etc. Both the AFD control PID loop and the independent PID loop shall continue functioning even if the serial communications connection is lost. The AFD shall keep the last good set-point command and last good DO & AO commands in memory in the event the serial communications connection is lost.

.8 EMI / RFI filters. All AFD's shall include EMI/RFI filters. The onboard filters shall allow the AFD assemble to be CE Marked and the AFD shall meet product standard EN 61800-3 for the First Environment restricted level.

.9 All AFD's through 50HP shall be protected from input and output power mis-wiring. The AFD shall sense this condition and display an alarm on the keypad.

.10 OPTIONAL FEATURES – Optional features to be furnished and mounted by the drive manufacturer. All optional features shall be UL Listed by the drive manufacturer as a complete assembly and carry a UL508 label.

.1 A complete factory wired and tested bypass system consisting of an output contactor and bypass contactor. Overload protection shall be provided in both drive and bypass modes.

.2 Door interlocked, padlockable circuit breaker that will disconnect all input power from the drive and all internally mounted options.

.3 Fused AFD only disconnect (service switch). Fast acting fuses exclusive to the AFD – fast acting fuses allow the AFD to disconnect from the line prior to clearing upstream branch circuit protection, maintaining bypass capability. Bypass designs, which have no such fuses, or that incorporate fuses common to both the AFD and the bypass will not be accepted. Three contactor bypass schemes are not acceptable.

.4 The following operators shall be provided:

.1 Bypass Hand-Off-Auto
.2 Drive mode selector
.3 Bypass mode selector
.4 Bypass fault reset

.5 The following indicating lights (LED type) shall be provided. A test mode or push to test feature shall be provided.

.1 Power-on (Ready)
.2 Run enable (safeties) open
.3 Drive mode select damper opening
.4 Bypass mode selected
.5 Drive running
.6 Bypass running
.7 Drive fault
.8 Bypass fault
.9 Bypass H-O-A mode
.10 Automatic transfer to bypass selected
.11 Safety open

.12 Damper opening
.13 Damper end-switch made

.6 The following relay (form C) outputs from the bypass shall be provided:
.1 System started
.2 System running
.3 Bypass override enabled
.4 Drive fault
.5 Bypass fault (motor overload or underload (broken belt))
.6 Bypass H-O-A position

.7 The digital inputs for the system shall accept 24V or 115VAC (selectable). The bypass shall incorporate internally sourced power supply and not require an external control power source.

.8 Customer Interlock Terminal Strip – provide a separate terminal strip for connection of freeze, fire, smoke contacts, and external start command. All external safety interlocks shall remain fully functional whether the system is in Hand, Auto, or Bypass modes (not functional in Fireman's Override 2). The remote start/stop contact shall operate in AFD and bypass modes.

.9 Dedicated digital input that will transfer motor from AFD mode to bypass mode upon dry contact closure for fireman's override. Two modes of operation are required.
.1 One mode forces the motor to bypass operation and overrides both the AFD and bypass H-O-A switches and forces the motor to operate across the line (test mode). The system will only respond to the digital inputs and motor protections.
.2 The second fireman's override mode remains as above, but will also defeat the overload and single-phase protection for bypass and ignore all keypad and digital inputs to the system (run until destruction).

.10 The AFD shall include a "run permissive circuit" that will provide a normally open contact whenever a run command is provided (local or remote start command in AFD or bypass mode). The AFD system (AFD or bypass) shall not operate the motor until it receives a dry contact closure from a damper or valve end-switch. When the AFD system safety interlock (fire detector, freezestat, high static pressure switch, etc) opens, the motor shall coast to a stop and the run permissive contact shall open, closing the damper or valve.

.11 Class 20 or 30 (selectable) electronic motor overload protection shall be included.

.12 There shall be an internal switch to select manual or automatic bypass.

.13 There shall be an adjustable current sensing circuit for the bypass to provide loss of load indication (broken belt) when in the bypass mode.

Part 3

3.1 INSTALLATION

.1 Installation shall be the responsibility of the mechanical and controls mechanical subcontractor. The mechanical subcontractor shall install the drive in accordance with the recommendations of the AFD manufacturer as outlined in the installation manual.

.2 Power wiring shall be completed by the electrical mechanical subcontractor. The mechanical subcontractor shall complete all wiring in accordance with the recommendations of the AFD manufacturer as outlined in the installation manual.

.3 Control Wiring shall be completed by the controls mechanical subcontractor. The mechanical subcontractor shall complete all wiring in accordance with the recommendations of the AFD manufacturer as outlined in the installation manual.

3.2 START-UP

.1 Certified factory start-up shall be provided for each drive by a factory authorized service center. A certified start-up form shall be filled out for each drive with a copy provided to the the City, and a copy kept on file at the manufacturer.

3.3 PRODUCT SUPPORT

.1 Factory trained application engineering and service personnel that are thoroughly familiar with the AFD products offered shall be locally available at both the specifying and installation locations. A 24/365 technical support line shall be available on a toll-free line.

.2 A computer based training CD or 8-hour professionally generated video (VCR format) shall be provided to the the City at the time of project closeout. The training shall include installation, programming and operation of the AFD, bypass and serial communication.

3.4 WARRANTY

.1 Warranty shall be 24 months from the date of certified start-up. The warranty shall include all parts, labor, travel time and expenses. There shall be 365/24 support available via a toll free phone number.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Sequence of operation:

.1 Air Handling Unit - AHU-1
.2 Energy Recovery Ventilator - ERV-1
.3 Variable Air Volume Terminal Unit with In-floor HTG and CLG - VAV-1, 2,
.4 In-floor Radiation
.5 Supply Fan Mechanical Room, F-1
.6 Crawlspace Supply & Exhaust Fan – F-2 & F-3
.7 Unit Heater UH-1
.8 Heating Primary Loop Pumps - P-1 & P-2
.9 Heating & Cooling Secondary Loop Pumps - P-3 & P-4
.10 Boiler Interface, B-1 and B-2
.11 Chiller Interface, CH-1
.12 Outside Air Conditions
.13 Blind Interface

1.2 SYSTEM DESCRIPTION

.1 This section defines the manner and method by which controls function.

.2 Requirements for each type of control system operation are specified.

.3 Equipment, devices, and system components required for control systems are specified in other Sections.

1.3 SUBMITTALS FOR REVIEW

.1 Section 21 05 00: Procedures for submittals.

.2 Shop Drawings: Indicate mechanical system controlled and control system components.

.1 Label with settings, adjustable range of control and limits. Include written description of control sequence.
.2 Include flow diagrams for each control system, graphically depicting control logic.
.3 Include draft copies of graphic displays indicating mechanical system components, control system components, and controlled function status and value.

1.4 SUBMITTALS AT PROJECT CLOSEOUT

.1 Section 21 05 00: Submittals for project closeout.

.2 Project Record Documents: Record actual locations of components and set points of controls, including changes to sequences made after submission of shop drawings.

Part 2 Products

2.1 Not Used

.1 Not Used

Part 3 Execution

3.1 AIR HANDLING UNIT, AHU-1 - VARIABLE AIR VOLUME

.1 Run Conditions - Scheduled:

.1 The unit shall run based upon an operator adjustable schedule.

.2 Emergency Shutdown:

.1 The unit shall shut down and generate an alarm upon receiving an emergency shutdown signal.

.3 Freeze Protection:

.1 The unit shall shut down and generate an alarm upon receiving a freezestat status.

.4 High Static Shutdown:

.1 The unit shall shut down and generate an alarm upon receiving a high static shutdown signal.

.5 Supply Air Smoke Detection:

.6 The unit shall shut down and generate an alarm upon receiving a supply air smoke detector status.

.7 Supply Fan:

.1 The supply fan shall run anytime the unit is commanded to run, unless shutdown on safeties. To prevent short cycling, the supply fan shall have a user definable (adj.) minimum runtime.

.2 Alarms shall be provided as follows:

.1 Supply Fan Failure: Commanded on, but the status is off.

.2 Supply Fan in Hand: Commanded off, but the status is on.

.3 Supply Fan Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).

.8 Supply Air Duct Static Pressure Control:

.1 The controller shall measure duct static pressure and modulate the supply fan VFD speed to maintain a duct static pressure setpoint. The speed shall not drop below 35% (adj.). The static pressure setpoint shall be reset based on zone cooling requirements.

.1 The initial duct static pressure setpoint shall be 100.0Pa (adj.).

.2 As cooling demand increases, the setpoint shall incrementally reset up to a maximum of 250 Pa (adj.).

.3 As cooling demand decreases, the setpoint shall incrementally reset down to a minimum of 60Pa (adj.) .

.4 Alarms shall be provided as follows:

.1 High Supply Air Static Pressure: If the supply air static pressure is 25% (adj.) greater than setpoint.

.2 Low Supply Air Static Pressure: If the supply air static pressure is 25% (adj.) less than setpoint.

.3 Supply Fan VFD Fault.

.9 Return Fan:

.1 The return fan shall run whenever the supply fan runs.

.2 Alarms shall be provided as follows:

.1 Return Fan Failure: Commanded on, but the status is off.

.2 Return Fan in Hand: Commanded off, but the status is on.

.3 Return Fan Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).

.4 Return Fan VFD Fault.

.10 Building Static Pressure Control:

.1 The controller shall measure building static pressure and modulate the return fan VFD speed to maintain a building static pressure setpoint of 5 Pa (adj.). The return fan VFD speed shall not drop below 20% (adj.).

.2 Alarms shall be provided as follows:

.1 High Building Static Pressure: If the building air static pressure is 25% (adj.) greater than setpoint.

.2 Low Building Static Pressure: If the building air static pressure is 25% (adj.) less than setpoint.

.11 Supply Air Temperature Setpoint - Optimized:

.1 The controller shall monitor the supply air temperature and shall maintain a supply air temperature setpoint reset based on zone cooling and heating requirements

.2 The supply air temperature setpoint shall be reset for cooling based on zone cooling requirements as follows:

.1 The initial supply air temperature setpoint shall be 13°C (adj.).

.2 As cooling demand increases, the setpoint shall incrementally reset down to a minimum of 11.5°C (adj.).

.3 As cooling demand decreases, the setpoint shall incrementally reset up to a maximum of 22°C (adj.) .

.12 Heating Modulation:

.1 The controller shall measure the supply air temperature and modulate the heating demand to maintain its Heating setpoint. To prevent short cycling, there shall be a user definable (adj.) delay between stages, and each stage shall have a user definable (adj.) minimum runtime.

.1 The Heating shall be enabled whenever:

.1 Outside air temperature is less than 15.5°C (adj.).

.2 AND the economizer (if present) is disabled or closed.

.3 AND the supply fan status is on.

.4 AND the cooling (if present) is not active.

.2 Alarms shall be provided as follows:

.1 High Supply Air Temp: If the supply air temperature is 35°C (adj.) greater than setpoint.

.13 Cooling Modulation:

.1 The controller shall measure the supply air temperature and modulate the cooling demand to maintain its cooling setpoint. To prevent short cycling, there shall be a user definable (adj.) delay between stages, and each stage shall have a user definable (adj.) minimum runtime.

.1 The cooling shall be enabled whenever:

.2 Outside air temperature is greater than 15.5°C (adj.).

.3 AND the economizer (if present) is disabled or fully open.

.4 AND the supply fan status is on.

.5 AND the heating (if present) is not active.

.2 Alarms shall be provided as follows:

.1 High Supply Air Temp: If the supply air temperature is 3°C (adj.) greater than setpoint.

.2 Low Supply Air Temperature Alarm:

.1 The controller shall alarm if the supply air temperature is less than 8°C (adj.).

.14 Economizer:

.1 The controller shall measure the mixed air temperature and modulate the economizer dampers in sequence to maintain a setpoint 1°C (adj.) less than the supply air temperature setpoint. The outside air dampers shall maintain a minimum adjustable position open whenever occupied. Refer to schedule.

.2 The economizer shall be enabled whenever:

.1 Outside air temperature is less than 18°C (adj.).

.2 AND the outside air enthalpy is less than 34kJ/kg (adj.)

.3 AND the outside air temperature is less than the return air temperature.

.4 AND the outside air enthalpy is less than the return air enthalpy.

.5 AND the supply fan status is on.

.3 The economizer shall close whenever:

.1 Mixed air temperature drops from 4.5°C to 1.5°C (adj.)

.2 OR the freezestat (if present) is on.

.3 OR on loss of supply fan status.

.4 The outside and exhaust air dampers shall close and the return air damper shall open when the unit is off. If Optimal Start Up is available the mixed air damper shall operate as described in the occupied mode except that the outside air damper shall modulate to fully closed.

.15 Final Filter Differential Pressure Monitor:

.1 The controller shall monitor the differential pressure across the final filter.

.2 Alarms shall be provided as follows:

.1 Final Filter Change Required: Final filter differential pressure exceeds a user definable limit (adj.).

.16 Mixed Air Temperature:

.1 The controller shall monitor the mixed air temperature and use as required for economizer control (if present) or preheating control (if present).

.2 Alarms shall be provided as follows:

.1 High Mixed Air Temp: If the mixed air temperature is greater than 33°C (adj.).

.2 Low Mixed Air Temp: If the mixed air temperature is less than 8°C (adj.).

.17 Return Air Humidity:

.1 The controller shall monitor the return air humidity and use as required for economizer control.

.2 Alarms shall be provided as follows:

.1 High Return Air Humidity: If the return air humidity is greater than 80% (adj.).

.2 Low Return Air Humidity: If the return air humidity is less than 25% (adj.).

.3 Return Air Temperature:

.1 The controller shall monitor the return air temperature and use as required for setpoint control or economizer control.

.2 Alarms shall be provided as follows:

.1 High Return Air Temp: If the return air temperature is greater than 33°C (adj.).

.2 Low Return Air Temp: If the return air temperature is less than 8°C (adj.).

.18 Return Air Carbon Dioxide (CO2) Concentration Monitoring:

.1 The controller shall measure the return air CO2 levels.

.1 Alarms shall be provided as follows:

.1 High Return Air Carbon Dioxide Concentration: If the return air CO2 concentration is greater than 1000 ppm (adj.) when the unit is running.

3.2 HEAT RECOVERY VENTILATOR (HRV-1)

.1 Run Conditions - Scheduled:

.1 The unit shall run based upon an operator adjustable schedule.

.2 Emergency Shutdown:

.1 The unit shall shut down and generate an alarm upon receiving an emergency shutdown signal.

.3 Supply Fan:

.1 The supply fan shall run anytime the unit is commanded to run, unless shutdown on safeties. To prevent short cycling, the supply fan shall have a user definable (adj.) minimum runtime.

.2 Alarms shall be provided as follows:

.1 Supply Fan Failure: Commanded on, but the status is off.

.2 Supply Fan in Hand: Commanded off, but the status is on.

.4 Exhaust Fan:

.1 The exhaust fan shall run anytime the unit is commanded to run, unless shutdown on safeties. To prevent short cycling, the Exhaust fan shall have a user definable (adj.) minimum runtime.

.2 Alarms shall be provided as follows:

.1 Exhaust Fan Failure: Commanded on, but the status is off.

.2 Exhaust Fan in Hand: Commanded off, but the status is on.

.5 Heat Recovery Ventilator Air Filter Differential Pressure Monitor:

.1 The controller shall monitor the differential pressure across the filter.

.2 Alarms shall be provided as follows:

.1 Filter Change Required: Final filter differential pressure exceeds a user definable limit (adj.).

.6 Supply Air Temperature:

.1 The controller shall monitor the supply air temperature.

.2 Alarms shall be provided as follows:

.3 Low Supply Air Temp: If the supply air temperature is less than -15°C (5 °F) (adj.).

.7 Exhaust Air Temperature:

.1 The controller shall monitor the supply air temperature.

.2 Alarms shall be provided as follows:

.3 Low Supply Air Temp: If the supply air temperature is less than -15°C (5 °F) (adj.).

.8 Exhaust Air Humidity:

.1 The controller shall monitor the return air humidity and use as required for economizer control.

3.3 VARIABLE AIR VOLUME - TERMINAL UNIT (WITH INFLOOR HEAT)

.1 Run Conditions - Scheduled:

.1 The unit shall run according to a user definable time schedule in the following modes:

.2 Occupied Mode: The unit shall maintain

.1 A 23.5°C (adj.) cooling setpoint

.2 A 21°C (adj.) heating setpoint.

.3 Unoccupied Mode (night setback): The unit shall maintain

.1 A 29.5°C (adj.) cooling setpoint.

.2 A 13°C (adj.) heating setpoint.

.4 Alarms shall be provided as follows:

.1 High Zone Temp: If the zone temperature is greater than the cooling setpoint by a user definable amount (adj.).

.2 Low Zone Temp: If the zone temperature is less than the heating setpoint by a user definable amount (adj.).

.2 Zone Setpoint Adjust:

.1 The occupant shall be able to adjust the zone temperature heating and cooling setpoints at the zone sensor.

.3 Zone Optimal Start:

.1 The unit shall use an optimal start algorithm for morning start-up. This algorithm shall minimize the unoccupied warm-up or cool-down period while still achieving comfort conditions by the start of scheduled occupied period.

.4 Zone Unoccupied Override:

.1 A timed local override control shall allow an occupant to override the schedule and place the unit into an occupied mode for an adjustable period of time. At the expiration of this time, control of the unit shall automatically return to the schedule.

.5 Reversing Variable Volume Terminal Unit - Flow Control:

.1 The unit shall maintain zone setpoints by controlling the airflow through one of the following:

.6 Occupied:

.1 When zone temperature is greater than its cooling setpoint, the zone damper shall modulate between the minimum occupied airflow (adj.) and the maximum cooling airflow (adj.) until the zone is satisfied.

.2 When the zone temperature is between the cooling setpoint and the heating setpoint, the zone damper shall maintain the minimum required zone ventilation (adj.).

.3 When zone temperature is less than its heating setpoint, the controller shall enable heating to maintain the zone temperature at its heating setpoint. Additionally, if warm air is available from the AHU, the zone damper shall

modulate between the minimum occupied airflow (adj.) and the maximum heating airflow (adj.) until the zone is satisfied.

.7 Unoccupied:

.1 When the zone is unoccupied the zone damper shall control to its minimum unoccupied airflow (adj.).

.2 When the zone temperature is greater than its cooling setpoint, the zone damper shall modulate between the minimum unoccupied airflow (adj.) and the maximum cooling airflow (adj.) until the zone is satisfied.

.3 When zone temperature is less than its unoccupied heating setpoint, the controller shall enable heating to maintain the zone temperature at the setpoint. Additionally, if warm air is available from the AHU, the zone damper shall modulate between the minimum unoccupied airflow (adj.) and the auxiliary heating airflow (adj.) until the zone is satisfied.

.8 Discharge Air Temperature:

.1 The controller shall monitor the discharge air temperature.

.2 Alarms shall be provided as follows:

.1 High Discharge Air Temp: If the discharge air temperature is greater than 49°C (adj.).

.2 Low Discharge Air Temp: If the discharge air temperature is less than 4.5°C (adj.).

.9 Infloor Coil Valve:

.1 The controller shall measure the zone temperature and modulate the in floor valve open to maintain its heating or cooling setpoint.

.2 In floor – Slab temperature

.1 The controller shall measure the slab temperature and adjust the infloor heating from 72°F to 80°F in heating (adj.).

.2 The controller shall measure the slab temperature and adjust the infloor heating from 74°F to 64°F in cooling (adj.).

.3

.3 Slab Temperature:

.1 The controller shall monitor the slab temperature.

.2 Alarms shall be provided as follows:

.1 High slab Temp: If the slab temperature is greater than 85°F (adj.).

.3 Low slab Temp: If the slab temperature is less than 60°F (adj.).

3.4 IN FLOOR RADIATION

.1 Run Conditions - Scheduled:

.1 The unit shall run according to a user definable time schedule in the following modes:

.2 Occupied Mode: The unit shall maintain

.1 A 74°F (adj.) cooling setpoint

.2 A 70°F (adj.) heating setpoint.

.3 Unoccupied Mode (night setback): The unit shall maintain

.1 A 78°F (adj.) cooling setpoint.

.2 A 62°F (adj.) heating setpoint.

.4 Alarms shall be provided as follows:

.1 High Zone Temp: If the zone temperature is greater than the cooling setpoint by a user definable amount (adj.).

.2 Low Zone Temp: If the zone temperature is less than the heating setpoint by a user definable amount (adj.).

.2 In-floor Coil Valve(s):

.1 The controller shall measure the zone temperature and modulate the in floor valve open to maintain its heating or cooling setpoint.

.2 In floor – Slab temperature

.1 The controller shall measure the slab temperature and adjust the infloor heating from 72°F to 80°F in heating (adj.).

.2 The controller shall measure the slab temperature and adjust the infloor heating from 74°F to 64°F in cooling (adj.).

.3 Slab Temperature:

.1 The controller shall monitor the slab temperature.

.2 Alarms shall be provided as follows:

.1 High slab Temp: If the slab temperature is greater than 85°F (adj.).

.3 Low slab Temp: If the slab temperature is less than 60°F (adj.).

.3 Air handling unit – AHU-1

.1 Additional heat to maintain the space temperature when space is unoccupied.

.1 AHU-1 shall stage on @ 50% supply flow and provide supplemental heating to maintain unoccupied heating setpoint.

3.5 FAN MECHANICAL ROOM, F-1

.1 Run Conditions - Scheduled:

.1 The fan shall run according to space temperature.

.2 The unit shall maintain a heating setpoint of 23°C (adj.).

.2 Fan:

.1 The fan shall have a user definable (adj.) minimum runtime.

.3 Outside Air Damper:

.1 The outside air damper shall open anytime the unit runs and shall close anytime the unit stops. The Relief air damper shall close 30 sec (adj.) after the fan stops.

.2 Alarms shall be provided as follows:

.1 Damper Failure: Commanded open, but the status is closed.

.2 Damper in Hand: Commanded closed, but the status is open.

.4 Damper Status:

.1 The fan shall be enabled after the damper status has proven.

.1 Alarms shall be provided as follows:

.1 Damper Failure: Commanded open, but the status is closed.

.2 Damper in Hand: Commanded closed, but the status is open.

.5 Fan Status:

.1 The controller shall monitor the fan status.

.2 Alarms shall be provided as follows:

.1 Fan Failure: Commanded on, but the status is off.

.2 Fan in Hand: Commanded off, but the status is on.

.3 Fan Runtime Exceeded: Fan status runtime exceeds a user definable limit (adj.).

3.6 CRAWLSPACE SUPPLY & EXHAUST FAN – F-2 & F-3

.1 Run Conditions:

.2 The unit shall be continuously enabled to maintain a zone temperature of less than 26°C (79°F) and humidity set points less than 50% RH (adj.).

.3 If the crawlspace temperature is less than 15°C (60°F). (adj.) Fans shall be disabled.

.4 Alarms shall be provided as follows:

.1 Low ambient Temperature: If the crawlspace temperature is less than 13°C 55°F. (adj.).

.5 Run Conditions:

.1 Fan shall be controlled by thermostat and dehumidistat located in the crawlspace. Fans shall be enabled to run when temperatures or humidity exceed set points.

.6 Modulating Air Damper:

.1 The air damper shall open anytime the unit runs and shall close anytime the unit stops. The exhaust air damper shall close 30 sec (adj.) after the fan stops.

.2 Damper Status:

.3 The fan shall be enabled after the damper status has proven.

3.7 UNIT HEATER UH-1

.1 Run Conditions – Temperature:

.1 The unit shall run according to a user definable temperature:

.2 The unit shall maintain

.1 The unit shall maintain a heating setpoint of 18°C (adj.).

.2 Zone Setpoint Adjust:

.1 The occupant shall be able to adjust the zone temperature heating and cooling setpoints at the zone sensor.

.3 Fan:

.1 The fan shall run anytime the zone temperature drops below heating setpoint, unless shutdown on safeties.

.4 Alarms shall be provided as follows:

.1 Low ambient Temperature: If the temperature is less than 15°C 60°F. (adj.). Alarm shall be audible in the mechanical room.

.2 High ambient Temperature: If the temperature is less than 26°C 79°F. (adj.). Alarm shall be audible in the mechanical room.

3.8 HEATING & COOLING PRIMARY LOOP PUMPS - P-1 & P-2

.1 Water Pump Run Conditions:

.1 The water pumps shall be enabled whenever:

.1 There is a call for heating.

.2 The pumps shall run for freeze protection anytime outside air temperature is less than 5°C (adj.).

.3 To prevent short cycling, the pump shall run for a minimum time and be off for a minimum time (both user adjustable).

.2 Heating Operation

.1 Water Pump Lead/Standby Operation:

.2 The two water pumps shall operate in a lead/standby fashion.

.1 The lead pump shall run first.

.2 On failure of the lead pump, the standby pump shall run and the lead pump shall turn off.

.3 The Lead pump shall stage on to meet the minimum flow of the boiler and modulate flow to maintain the air handler's discharge air temperature setpoint.

.4 The designated lead pump shall rotate upon one of the following conditions (user selectable):

.1 manually through a software switch

.2 if pump runtime (adj.) is exceeded

.1 daily

.2 weekly

.3 monthly

.5 Cooling Operation

.1 Water Pump Parallel Operation:

.1 The two water pumps shall operate in a parallel fashion to maintain a constant flow.

.6 Alarms shall be provided as follows:

.1 Water Pump 1

.1 Failure: Commanded on, but the status is off.

.2 Running in Hand: Commanded off, but the status is on.

.3 Runtime Exceeded: Status runtime exceeds a user definable limit.

.4 Fault.

.2 Water Pump 2

.1 Failure: Commanded on, but the status is off.

.2 Running in Hand: Commanded off, but the status is on.

.3 Runtime Exceeded: Status runtime exceeds a user definable limit.

.4 Fault.

.7 Water Temperature Monitoring:

.1 The following temperatures shall be monitored:

.1 Water supply.

.2 Water return.

.2 Alarms shall be provided as follows:

.1 High Water Supply Temp: If the water supply temperature is greater than 90°C (adj.).

.2 Low Water Supply Temp: If the water supply temperature is less than 38°C (adj.).

3.9 HEATING & COOLING SECONDARY LOOP PUMPS - P-3 & P-4

.1 Water Pump Run Conditions:

.1 The water pumps shall be enabled whenever:

.1 The in floor radiant system needs heating or cooling.

.2 The pumps shall run for freeze protection anytime outside air temperature is less than -10°C (adj.).

.3 To prevent short cycling, the pump shall run for a minimum time and be off for a minimum time (both user adjustable).

.4 Water Pump Lead/Standby Operation:

.1 The two water pumps shall operate in a lead/standby fashion.

.1 The lead pump shall run first.

.2 On failure of the lead pump, the standby pump shall run and the lead pump shall turn off.

.5 The designated lead pump shall rotate upon one of the following conditions (user selectable):

.1 manually through a software switch

.2 if pump runtime (adj.) is exceeded

.1 daily

.2 weekly

.3 monthly

.6 Alarms shall be provided as follows:

.1 Water Pump 1

.1 Failure: Commanded on, but the status is off.

.2 Running in Hand: Commanded off, but the status is on.

.3 Runtime Exceeded: Status runtime exceeds a user definable limit.

.4 Fault.

.2 Water Pump 2

.1 Failure: Commanded on, but the status is off.

.2 Running in Hand: Commanded off, but the status is on.

.3 Runtime Exceeded: Status runtime exceeds a user definable limit.

.4 Fault.

.7 Hot Water Differential Pressure Control:

.1 The controller shall measure the water differential pressure and modulate the pump in sequence to maintain its water differential pressure setpoint.

.2 The following setpoints are recommended values. All setpoints shall be field adjusted during the commissioning period to meet the requirements of actual field conditions.

.1 The controller shall modulate water pump speeds to maintain a water differential pressure of 83kPa (adj.).

.2 On dropping water differential pressure, the pumps shall stage on and run to maintain setpoint as follows:

.1 The controller shall modulate the lead pump to maintain setpoint.

.3 On rising water differential pressure,

.1 The controller shall modulate the lead pump to maintain setpoint.

.3 Alarms shall be provided as follows:

.1 High Water Differential Pressure: If 25% (adj.) greater than setpoint.

.2 Low Water Differential Pressure: If 25% (adj.) less than setpoint.

.8 Water Temperature Monitoring:

.1 The following temperatures shall be monitored:

.1 Water supply.

.2 Water return.

.2 Alarms shall be provided as follows:

.1 High Water Supply Temp: If the water supply temperature is greater than 50°C (adj.).

.2 Low Water Supply Temp: If the water supply temperature is less than 13°C (adj.).

3.10 BOILER INTERFACE MONITOR:

.1 Current boiler status and operating conditions will be monitored through its communications interface port. The interface will monitor and trend all points from the from the boiler controller.

.2 Boiler System Run Conditions:

.1 The boiler system shall be enabled to run whenever:

.2 A definable number of hot water coils need heating.

.3 AND outside air temperature is less than 18°C (adj.).

.4 To prevent short cycling, the boiler system shall run for and be off for minimum adjustable times (both user definable), unless shutdown on safeties or outside air conditions.

.3 The boiler shall run subject to its own internal safeties and controls.

.4 Boiler Water Isolation Valve:

.1 The valve shall open anytime the boiler is called to run. The valve shall also open whenever the water pump runs for freeze protection.

.2 The valve shall open prior to the boiler being enabled and shall close only after the boiler is disabled. The valve shall therefore have:

.1 A user adjustable delay on start.

.2 AND a user adjustable delay on stop.

.3 The delay times shall be set appropriately to allow for orderly boiler water system start-up, shutdown and sequencing.

.4 Alarms shall be provided as follows:

.1 Failure: Valve commanded open but the status indicates closed.

.2 Open in Hand: Valve commanded closed but the status indicates open.

.5 Supply water Reset:

.1 The Controller shall reset the supply water temperature based on outside air temperature

.6 Primary Hot Water Temperature Monitoring:

.1 The following temperatures shall be monitored:

.1 Primary hot water supply.

.2 Primary hot water return.

.2 Alarms shall be provided as follows:

.1 High Primary Hot Water Supply Temp: If greater than 94°C (adj.).

.2 Low Primary Hot Water Supply Temp: If less than 38°C (adj.).

.7 Boiler valve end switches shall be monitored to enable the pump from either P-1 or P-2.

.1 Boiler 1 End Switch

.2 Boiler 2 End Switch.

3.11 AIR COOLED CHILLER

.1 Chiller - Run Conditions:

.1 The chiller shall be enabled to run whenever it is commanded to be enabled by the chiller manager program. The chiller shall run subject to its own internal safeties and controls.

.2 Chilled Water Isolation Valve:

.1 The valve shall open anytime the chiller is called to run.

.2 The valve shall open prior to the chiller being enabled and shall close only after the chiller is disabled. The valve shall therefore have:

.1 A user adjustable delay on start.

.2 AND a user adjustable delay on stop.

.3 The delay times shall be set appropriately to allow for orderly chilled water system start-up, shutdown and sequencing.

.4 Alarms shall be provided as follows:

.1 Failure: Valve commanded open but the status indicates closed.

.2 Open in Hand: Valve commanded closed but the status indicates open.

.3 Chiller:

.1 The chiller shall be enabled a user adjustable time after pump statuses are proven on. The chiller shall therefore have a user adjustable delay on start.

.1 The delay time shall be set appropriately to allow for orderly chilled water system start-up, shutdown and sequencing.

.2 The chiller shall run subject to its own internal safeties and controls.

.1 Alarms shall be provided as follows:

.1 Chiller Failure: Commanded on, but the status is off.

.2 Chiller Running in Hand: Commanded off, but the status is on.

.3 Chiller Runtime Exceeded: Status runtime exceeds a user definable limit.

.3 Chilled Water Temperature Monitoring:

.1 The following temperatures shall be monitored:

.1 Chilled water supply.

.2 Chilled water return.

.4 Alarms shall be provided as follows:

.1 High Chilled Water Supply Temp: If the chilled water supply temperature is greater than 13°C (adj.).

.2 Low Chilled Water Supply Temp: If the chilled water supply temperature is less than 4°C (adj.)

3.12 OUTSIDE AIR CONDITIONS

.1 The controller shall monitor the outside air temperature and humidity and calculate the outside air enthalpy on a continual basis. These values shall be made available to the system at all times.

.2 Alarm shall be generated as follows:

.1 Sensor Failure: Sensor reading indicates shorted or disconnected sensor. In the event of a sensor failure, an alternate outside air conditions sensor shall be made available to the system without interruption in sensor readings.

.3 If an OA Temp Sensor cannot be read, a default value of 18.5°C will be used.

.4 If an OA Humidity Sensor cannot be read, a default value of 50 % will be used.

.5 Outside Air Temperature History:

.1 The controller shall monitor and record the high and low temperature readings for the outside air. These readings shall be recorded on a daily, month-to-date, and year-to-date basis.

3.13 BLIND INTERFACE

.1 The controller shall be connected to the blind controller. System shall monitor blind status and alarms.

.1 The Blinds shall run subject to its own internal controls and safeties.

.2 Alarm shall be generated as follows:

.1 Sensor Failure, motor failure, any other alarm point generation.

END OF SECTION