SECTION 15975

AUTOMATIC TEMPERATURE CONTROLS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. A fully integrated Automatic Temperature Control (ATC) Building Management and Control System incorporating Direct Digital Control (DDC), energy management, equipment monitoring, and control consisting of the following:
   1. Microcomputer based equipment controllers interfacing directly with sensors, actuators and environmental delivery systems
   2. Electric controls and mechanical devices for items indicated on Drawings and described hereinafter including dampers, valves, and motor drives.
   3. Microcomputer based terminal controllers interfacing with sensors, actuators, and terminal equipment control devices.

B. Submittals, data entry, electrical installation, programming, start up, test and validation, instruction of Owner's representative on maintenance and operation, as built documentation, and system warranty.

1.02 SYSTEM SUMMARY

A. The intent of this project is to provide a new DDC control system with electric actuators and graphical user interface.

B. Cabinet unit heaters, unit heaters and terminal heating units which are designated to be controlled by a thermostat shall be “stand-alone” control and shall not be interfaced with the ATC control system.

C. Rooftop units, exhaust fans, and terminal heating units which are designated to be controlled by a temperature sensor shall be interfaced with the ATC control system such that monitoring and setpoint adjustment shall be accomplished through the touch screen graphical user interface at the DDC central control panel.

1.03 SUBMITTALS

A. Submit in accordance with section 01300.

B. Submittal Shall Consist of:
   1. System architecture showing digital devices.
   2. Data sheets of products.
   3. Valve, damper, and well and tap schedules showing size, configuration, capacity and location of equipment.
   4. Wiring and piping interconnection diagrams including panel and device power and sources.
   5. Equipment lists of proposed devices and equipment.
   6. Software design data including flowchart of each direct digital control program showing interrelationship between inputs, outputs, PID functions, and other functions.

C. Codes and Approvals:
   1. The complete temperature control installation shall be in strict accordance to the national and local electrical codes and the electrical section of these specifications. Devices designed for or used in line voltage applications shall be UL listed. Microprocessor based remote and central devices shall be UL916 Listed.
   2. Electronic equipment shall conform to the requirements of FCC regulation Part 15, Section 15 governing radio frequency electromagnetic interference and be so labeled.

1.04 MANUALS

A. The Following Manuals Shall Be Provided:
   1. An Operator's Manual shall be provided with graphic explanations of keyboard use for operator functions specified under Operator Training.
   2. Computerized printouts of equipment controllers data file construction including point processing assignments, physical terminal relationships, scales and offsets, command and alarm limits, etc.
   3. A manual shall be provided including revised as-built documents of materials required under the paragraph "SUBMITTALS" on this specification.
   4. Two Operators Manuals, and two As-Built Manuals shall be provided to the Owner.

1.05 WARRANTY

A. Components, system software, parts and assemblies supplied by the temperature control contractor shall be guaranteed against defects in materials and workmanship for one year from acceptance date.

B. Labor to troubleshoot, repair, reprogram, or replace system components shall be furnished by the temperature control contractor at no charge to the Owner during the warranty period.

C. Corrective software modifications made during warranty service periods shall be updated on user documentation and on user and manufacturer archived software disks.

1.06 WORK BY OTHERS

A. Access doors, setting in place of valves, water pressure and differential taps, setting in place of thermal wells, setting in place of dampers.

PART 2 - PRODUCTS

2.01 ACCEPTABLE SUPPLIERS

A. Acceptable Manufacturers and Installers:
   1. Trane.
   2. Carrier.
   3. York.

2.02 SYSTEM REQUIREMENT

A. Provide complete direct digital and electronic control system consisting of temperature sensors, thermostats, dampers, operators, indicating devices, interface equipment, and other apparatus required to operate mechanical system and to perform functions specified. Provide controls for the following:
   1. Rooftop units.
   2. VAV boxes.
   3. VAV box with electric reheat.
   4. Packaged terminal heat pumps.
   5. Electric cabinet unit heaters.
   6. Graphical user interface.

2.03 THERMOSTATS

A. Freezestat safety low limit shall be duct-mounted manual reset twenty foot limited fill type responsive to the coolest section of its length.

B. Electric thermostats shall be line voltage or low voltage type, suitable for the application. They shall have exposed setpoint adjustment and setpoint indicator. Electric thermostats shall be provided with manual adjustment dials and shall be protected by lockable tamper proof covers.

C. Unit heater aquastats shall be strap-on type.

D. For thermostats that are located in high traffic and non-secure areas, provide tamper-proof covers. These areas shall include, but are not limited to:
   1. Lobbies.
   2. Stairwells.

2.04 TEMPERATURE SENSORS

A. Temperature sensors shall provide a two-wire connection to the controller that is polarity and wire type insensitive. Temperature sensors shall have a communications jack for connection to the communication trunk to which the controller is connected. The temperature sensor, the connected controller, and other devices on the communications bus shall be accessible by the Graphical Programming tool.

B. Temperature sensors shall be provided with manual adjustment dials. Adjustment dials shall be programmable through the operator workstation to allow a maximum and minimum range for user adjustment. The max/min range shall initially be set at 68°F min/72°F max.

C. Temperature sensors shall be provided with override buttons which, when depressed during unoccupied time periods, will override the zone's temperature controls and setpoints to occupied conditions for a user adjustable period of time (initially set for 2 hours).

D. For temperature sensors that are located in high traffic and unsecure areas, provide tamper-proof covers. These areas include, but are not limited to:
   1. Lobbies.
   2. Stairwells.

2.05 AUTOMATIC DAMPERS

A. Provide automatic control dampers not specified to be integral with other equipment. Frames shall not be less than 13-gauge galvanized steel. Blades shall not be over 8 inches wide nor less than 16-gauge galvanized steel roll formed. Bearings shall be oilite, ball-bearing or nylon with ½" shafts. Side seals shall be stainless steel of the tight-seal spring type.

B. Proportional control dampers shall be opposed blade type and two-position dampers shall be parallel blade types.

C. Dampers shall be ultra-low leakage type, the blade edges shall be fitted with replaceable, snap-on, inflatable seals to limit damper leakage to 6 CFM per square foot at 1 inch of WC. The temperature control manufacturer shall submit leakage data for control dampers with the temperature control submittal.

D. Automatic control dampers shall be fabricated of materials that are similar to the ductwork in which they are installed.

2.06 DAMPER ACTUATORS

A. Damper and valve actuators shall be by BELIMO or approved equal. Actuators shall satisfy of the following requirements:
   1. Electronic direct-coupled actuation shall be provided on dampers and valves.
   2. The actuator shall be direct-coupled, enabling it to be mounted directly to the damper or valve without the need for connecting linkage. The fastening clamp assembly shall be of a "V" bolt

design with associated "V" shaped toothed cradle attaching to the shaft for maximum strength and eliminating slippage. Spring return actuators shall have a "V" clamp assembly of sufficient size to be directly mounted to an integral jack-shaft of up to 1.05 inches when the damper is constructed in this manner. Set-screw type fasteners are not acceptable.

3. The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the entire rotation of the actuator. Mechanical end switches or magnetic clutch to deactivate the actuator at the end of rotation are not acceptable.
4. For power-failure/safety applications, an internal mechanical spring return mechanism shall be built into the actuator housing. Non-mechanical forms of fail-safe operation are not acceptable.
5. Proportional actuators shall provide a standard built-in 2 to 10 VDC position feedback signal, and other types of actuators shall be capable of providing an optional position feedback signal.
6. 24 VAC/VDC actuators shall operate on Class 2 wiring and shall not require more than 10 VA for AC or more than 8 watts for DC applications. Actuators operating on 120 VAC power shall not require more than 10 VA. Actuators operating on 230 VAC power shall not require more than 11 VA.
7. Non-spring return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring return actuators with more than 60 in-lb. torque capacity shall have a manual crank for this purpose.
8. Actuators shall be provided with a conduit fitting and a minimum three-foot electrical cable and shall be pre-wired to eliminate the necessity of opening the actuator housing to make electrical connections.
9. Actuators used near outdoor air streams shall have a NEMA 2 rated housings for water and moisture resistance. Other actuators shall have NEMA 1 rated housings.
10. Actuators shall produce no more than a 45 dB(A) noise level when powered and operating, and no more than a 62 dB(A) noise level when in the spring return mode.
11. Actuators shall be Underwriters Laboratories Standard 873 listed and Canadian Standards Association Class 4813 02 certified as meeting correct safety requirements and recognized industry standards.
12. Actuators shall be designed for a minimum of 60,000 full stroke cycles at the actuator's rated torque and shall have a 2-year manufacturer's warranty, starting from the date of installation Manufacturer shall be IS09001 certified.

B. Automatically controlled devices, unless specified otherwise elsewhere, shall be provided with electric actuators sized to operate their appropriate loads with sufficient reserve power to provide smooth modulating action or two-position action and tight close-off.

C. Where two or more actuators are to be operated in sequence with each other, sequencing shall be by digital sequencing with separate analog outputs, as specified in the sequence of operation.

D. Unless otherwise indicated, actuators shall be spring loaded and shall, upon a loss of power, actuate their device to an appropriate “fail safe” position.
   1. Outside and exhaust air dampers - fail safe to fully closed
   2. Exhaust fan motorized dampers - fail safe to fully closed

E. For actuators that are required to “fail safe”, provide spring return actuators. “Floating point” actuators shall not be allowed for these applications. “Floating point” actuators shall be allowed for actuators that are not required to “fail safe”.

2.07 DATA INPUTS AND OUTPUTS

A. Input/output sensors and devices shall be closely matched to the requirements of the remote panel for accurate, responsive, noise-free signal input/output. Control input response shall be high sensitivity and matched to the loop gain requirements for precise and responsive control.

B. Duct temperature sensors shall be rigid stem or averaging type as required. Provide water sensors with a separable copper, monel or stainless-steel well.

C. Differential and Static Pressure Sensors and Switches:
   1. Fan proof-of-flow switches shall be adjustable set point and differential pressure type. Current sensors shall be allowed, provided that they are capable of detecting a belt break.
   2. Pump proof-of-flow switches shall be adjustable differential pressure type.

D. Control relays and analog output transducers shall be compatible with equipment controllers output signals. Relays shall be suitable for the loads encountered. Analog output transducers shall be designed for precision closed loop control with pneumatic repeatability error no greater than 1½%.

2.08 DDC CENTRAL CONTROL PANEL

A. The control system shall consist of a system panel with graphical interactive touch screen display that will monitor and have the ability to edit all central controller setpoint and operating parameters and terminal unit controller setpoints and operating parameters. All standard setup and daily operator functions shall be available through the touch screen display. The installer shall be able to install, configure, and commission the entire system to operate on a schedule and to specific setpoints without the use of a personal computer. A single red flashing LED for indicating alarm conditions shall be displayed at the panel. A single green LED indicating normal operation shall be displayed at the panel.

B. Upon system panel power-up, all connected units, auxiliary loads, outdoor air sensor, and/or zone dampers shall automatically identify themselves over the communication link. The following capabilities shall be editable for the auto-configured units and zone dampers from the local touch screen display.
   1. Setting the system time and date.
   2. Setting unit(s) or zone(s) with occupied and unoccupied daily schedules. Ten schedules are available for grouping the devices and HVAC equipment on the Tracker.
   3. Initiating timed override for extended occupied operation for each unit for a fixed time interval.
   4. Enable, disable, or limit the range of the setpoint indicator on the zone sensor.
   5. Allow the operator to custom name devices.
   6. All connected auxiliary loads controlled through a system binary output shall be independently editable for scheduling from the local touch screen display.
   7. Detailed equipment status shall be available with no end user programming. Points available: Standard LonTalk Communications profile for a space comfort controller (SCC) profile on a rooftop unit.
      a. Inputs: space temperature, setpoint, setpoint offset, occupancy schedule, occupancy manual command (override), occupancy sensor, application mode, HVAC mode heat/cool, fan mode, compressor enable, auxiliary heat enable, econ enable, emergency override, object request input.
      b. Outputs: space temperature, effective setpoint, unit status, effective occupancy, HVAC mode heat/cool, setpoint, fan speed, discharge air temp, abs power consumption, terminal load output, space RH, outdoor RH, outdoor temperature, alarm message output.
      c. Configuration: heartbeat, location label, bypass time, outdoor air damper position, unit type, supply fan configuration, cool type, heat type.

C. Power shall be 24V, 50/60 Hz. The control system shall contain its own on-board isolation transformer or a dedicated transformer shall be provided.

D. Operating temperature range shall be 32 °F to 120 °F.

E. Operating humidity range shall be 10% to 90% non-condensing.

2.09 EMBEDDED SOFTWARE OR PANEL OPERATING SYSTEM

A. Software Integrity - All schedules and setpoints shall be resident in EEPROM along with the clock function. If battery backup is required to maintain software or the system clock as described above, this contractor shall provide battery maintenance for five years from date of project acceptance; costs to be included in this bid.

B. The touch screen display shall prompt the infrequent user for alarms, schedules, viewing equipment or zones, initiating timed overrides, and setup. Once a prompt has been selected the operators interface shall provide adjustment of:
   1. The system time and date
   2. Heating and cooling, occupied and unoccupied setpoints for each zone or constant volume unit
   3. Changing and copying schedules for each unit or zone, or load
   4. Viewing alarms
   5. Monitoring temperatures, operating modes, on/off statuses and failure conditions
   6. Holiday and exception dates
   7. Units of temperature
   8. Daylight savings time
   9. Optimal start

C. Time-of-day scheduling:
   1. The system panel shall allow ten schedules to group devices. Each schedule shall be able to have a separate schedule with two on and two off events per day. The panel shall be capable of optimally starting (achieving desired conditions at precise time of occupancy) the HVAC units based on individual unit recovery ramps.
   2. Time of day scheduling shall be continuous, such that if power is lost, on power-up the panel will look back for each device to see whether it should be on/off or in occupied/unoccupied temperature setpoints. If necessary, the software will look back at the previous day's schedules to determine the desired state of each device/zone.

D. Holiday and Exception Schedules: Through the central panel or computer there shall be a minimum of twenty defined holiday or exception dates.

E. Alarm log: The last 64 alarms shall be maintained for review at the building control panel display or connected computer. The panel shall have the capability to call out on the modem to a pager and deliver the alarm or event.

F. Optimum start: The software shall determine the optimum time to turn on the rooftop equipment based upon the previous day's recovery ramp. The software shall store this data and make daily corrections to the degrees/hour ramp.

G. Timed override: Each scheduled device shall be able to be overridden at the system control panel to the occupied mode for up to four hours. The override shall also be cancelable from the control panel at any time during the override.

H. Daylight Savings Time:
   1. The system panel software shall automatically update time according to daylight savings at the legislated time and date and reset time at the end of the daylight savings period. This function shall be able to be disabled.
   2. In addition, if the legislative dates for the start and stop of daylight savings time should be changed, the system panel shall be editable to calculate the new dates based on day-of-the-month, week-in-the-month, and the month and then automatically resume the new daylight savings parameters.

I. Temperature units: All temperature inputs connected directly to the control panel or communicating over the communications link shall be able to display temperature inputs in °F or in °C, selectable from the front keypad.

J. Multiple languages: The control panel display shall support multiple languages. Available languages shall be selectable at time of setup.

K. Security: Upon initial start up the factory default security level shall secure the building control panel from each of the following local capabilities: changing time and date, changing setpoints, changing schedules, and initiating timed override. The security password shall be provided in the installation manual.

L. Expansion: The ability to add additional HVAC units to the system without any additional hardware.

M. Modem: A modem shall be provided to allow for complete dial-in access. It shall be possible to retrieve and save a system panels database and to download that database from a remote location over standard telephone lines.

N. Local Area Network (LAN): An ethernet card shall be optional. The LAN option shall allow the system control panel and PC workstation to reside on an existing owner provided ethernet LAN infrastructure. Each system control panel on the network shall be capable of routing alarms and messages to a single user designated PC workstation or email address.

O. The integral model shall also enable auto-dial out of alarms including equipment failures and temperatures out-of-range for automatic annunciation and logging at a remote PC workstation location or pager.

P. Critical alarms: The operator shall be able to designate certain alarms as critical. Any critical alarm can be set up to dial-out to a remote location, while a non-critical alarm will not initiate a dial-out.

Q. Security: Multi-level (daily operator and system supervisor) security must allow or deny editing access to various supervisor-designated parts of the system. Security shall protect editing of the system features available on the touch screen display as well as through the computer interface. Security shall not prevent "viewing" any display screen regardless of assigned security level.

R. Automatic restart of all HVAC systems after power outage.

2.10 ROOFTOP UNIT CONTROLS

A. The system control panel shall be capable of communicating with each individual rooftop and monitoring various points. The control manufacturer shall provide one controller (central control base panel) per rooftop that communicates back to the main control panel. The rooftop controller shall communicate to the main control panel in an industry standard open protocol.

B. The control panel shall provide the following control functions for each rooftop unit.
1. Turn each compressor on or off.
2. On/Off/Auto mode control.
3. Schedule all rooftops for heating night setback.
4. Schedule all rooftops for a heating morning warmup.
5. Schedule all rooftops for optimum start and provide a program that automatically adjusts on a daily basis the morning start-up time based on the zone temperature versus the occupied setpoint and the historical recovery rate for each unit.
6. Economizer control for each unit.

C. Each rooftop shall be provided with a sensor that has an after hours override button. The occupant shall be able to override any scheduled night setback/setup period for two hours of after hours comfort by depressing the button for a period of 2-5 seconds. The override shall also be cancelable from the sensor at any time during the override with the use of a cancel button.

2.11 COMPUTER SOFTWARE

A. There shall be computer software available to allow the user complete access to the control panel by using the computers serial or ethernet card port and connecting via a jumper cable to a built on PC port on the control panel.

B. There shall be computer software available to allow the user complete access to the control panel by using the modem in the computer to communicate with the modem on the control panel.

C. System Graphics: The operator workstation software shall be graphically oriented. Provide a method for the operator to easily move between graphic displays.

D. System Applications: Each workstation shall provide operator interface and off-line storage of system information. Provide the following applications at each workstation:
   1. Manual database save and restore: A system operator with the proper password clearance shall be able to archive the database from any system panel and store. The operator shall also be able to clear a panel database and manually initiate a download of a specified database to any panel in the system.
   2. System configuration: The workstation software shall provide a graphical method of configuring the system.
   3. On-line help: Provide on-line help system to assist the operator in operation and editing of the system. On-line help shall be available for all applications.
   4. Security: System security shall be selectable for each two classes of operators. The system supervisor shall have the ability to set passwords and security levels for all applications and editable screens. The operator password shall be able to restrict the operators' access for changing system application, full screen editor, and objects. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected. All system security data shall be stored in an encrypted format.
   5. System Diagnostics: The system shall automatically monitor the operation of all network connections, building management panels, and controllers. The failure of any device shall be annunciated to the operator.
   6. Alarm Processing: Any object in the system shall be configurable to alarm in an out of normal state. The operator shall be able to configure the alarm limits, warning limits, states, and reactions for each object in the system.
      a. Alarm reactions: The operator shall be able to determine what actions, if any, are to be taken, by object (or point), during an alarm. Actions shall include making a contact closure on a binary output to create an audible annunciation or light, displaying a red flashing LED on the external cover of the control panel, custom or standard text messages in the alarm log, dialing out to a pager or paging service. Each of these actions shall be configurable by alarm class.
      b. Binary Alarms: Each binary object shall be set to alarm based on the operator-specified state.
      c. Analog Alarms: Each analog object shall have both high and low alarm limits and warning limits.

2.12 AUXILIARY DEVICES

A. The control panel shall be able to monitor up to 16 UIPs (universal inputs) user defined as °F or °C, PPM (parts per million), or % relative humidity.

B. The control panel shall be able to control up to 16 binary outputs individually based on time of day scheduling and/or user defined logic.

C. The control panel shall be able to communicate with a variety of HVAC equipment including packaged gas fired rooftop units, and multiple stage/compressor units.

2.13 INSTALLATION

A. Wiring and conduits shall be properly supported and run in a neat and workmanlike manner. Wiring and conduits exposed and in equipment rooms shall run parallel to or at right angles to the building structure. Wiring and conduits within enclosures shall be neatly bundled and anchored to prevent obstruction to devices and terminals.

B. The temperature control contractor shall be responsible for electrical installation, including low voltage and line voltage wiring, required for a fully functional control system and not shown on the electrical plans or required by the electrical specifications. Wiring shall be in accordance with local and national codes. Control wiring in boiler room, mechanical room and equipment rooms shall be installed in conduit which shall comply with the requirements of the electrical specifications. Electronic wiring shall be #18 AWG minimum THHN and shielded if required.

C. The temperature control contractor shall enter computer programs and data files into the related computers including control programs, initial approved parameters and settings, and English descriptors.

D. The temperature control contractor shall maintain CD copies of data file and application software for reload use in the event of a system crash or memory failure. One copy shall be delivered to the Owner during training session, and one copy shall be archived in the temperature control contractor's local software vault.

E. Adjustment/relocation of freezestats shall be performed by the temperature controls contractor as required to eliminate nuisance freezestat alarms.

F. Any temperature control panels required in addition to those shown on the drawings shall be powered by the controls contractor.

G. Wall mounted thermostats and temperature sensors shall be attached either to a wall stud or to blocking, or to an electrical wall box attached to such wall framing. Attaching to gypsum wallboard only shall not be allowed.

H. Aquastats installed on unit heaters and at any location above 5'-0" (1525 mm) above finished floor shall be installed with adjustment knobs facing downward to facilitate adjustment.

I. Outdoor air temperature sensor(s) shall be installed on the North side of the building.

J. Thermostats and temperature sensors are shown on the drawings for general location. Terminal heat transfer units and fans which control space temperature shall be provided with thermostatic control, whether or not a thermostat or temperature sensor has been shown on the drawings.

2.14 SPARE POINTS

A. Provide a minimum of 10% spare points or 16 spare points, whichever is greater, in each ATC control panel for future use. Spare points shall be equally distributed among analog input, analog output, digital input and digital output.

2.15 VALIDATION

A. The temperature control contractor shall completely check out, calibrate and test connected hardware and software to insure that the system performs in accordance with the approved specifications and sequences of operations submitted.

B. Witnessed Validation Demonstration Shall Consist of:
1. Display and demonstrate each type of data entry to show site specific customizing capability.
2. Execute digital and analog commands.
3. Demonstrate ATC loop precision and stability via trend logs of inputs and outputs.
4. Demonstrate energy management performance via trend logs and command trace.

2.16 TRAINING

A. Training shall be by the temperature control contractor and shall utilize specified manuals and as-built documentation.

B. Operator training shall include 2 four-hour sessions encompassing:
   1. Modifying text.
   2. Sequence of Operation review.
   3. Selection of all displays and reports.
   4. Use of all specified functions.
   5. Setting and adjusting of occupancy schedules.
   6. Troubleshooting of sensors.
   7. Owner questions/concerns.

C. One training session shall be conducted at project substantial completion, and the others shall be conducted at the Owner's request and in accordance with the Owner's schedule within a period of 6 months after substantial completion of the project.

D. At six months after substantial completion, all unused training hours shall be, at the Owner's discretion, used for future training of new personnel or reimbursed to the Owner at the contractor's current hourly service rate.

PART 3 - SEQUENCE OF OPERATION

3.01 ALARMS

A. Provide the Capability to Generate Alarms, Complete with Individualized per Point Alarm Message. Alarms shall be disabled when their associated system has been disabled as part of a standard control function.

B. Environmental Alarms:
   1. A digital output point shall be provided to deliver an environmental alarm signal to the building's security system. Provide digital output point and associated wiring to the security panel. Final connection to security panel shall be by division 16 (coordinate with division 16). The environmental alarm shall be a single point. The following alarm conditions shall activate the environmental alarm:
      a. Low temperature (below 50°F) at each temperature sensor.
      b. Duct furnace (DF-1) flame failure.
      c. Make-up Air unit MAU-1 gas heat frame failure.
      d. Low and high temperature alarm 2nd floor plenum.

3.02 PACKAGED THERMAL HEAT PUMPS (PTHP-1, 2, 3)

A. Controls shall be full solid state with two rotary knobs controlling the units operational mode and temperature setpoint. Operational modes shall include:
   1. Off position
   2. Fan only
   3. Low cool
   4. High cool
   5. Low heat
   6. High heat
   7. Fan (on)
   8. Fan (auto)

B. Fan and refrigeration system (cooling/heating) shall cycle on demand from unit mounted thermostat.

C. A changeover thermostat, sensing an outside coil switch over temperature of 20°F shall de-energize the heat pump and engage the units electric resistance heaters.

D. Room freeze protection: Electric resistance heater will activate when room thermostat senses a temperature of 40°F.

E. Electric heat will engage automatically if the sealed system or compressor fail.

F. Unit shall be enabled during occupied mode and disabled during unoccupied mode as determined by the building occupancy schedule (summer only).

3.03 EXHAUST FANS (EF-1, 2 & 3)

A. The following fan shall be on during occupied mode and off during unoccupied mode, as determined by the building occupancy schedule. When the fan receives a command to start, its motorized damper shall open and upon closure of a damper auxiliary switch, the fan shall start. When the fan receives a command to stop, the fan shall stop and the damper shall close.
1. EF-1, serving toilet rooms.

B. The following fan shall be controlled by a local temperature sensor. As space temperature increases above setpoint (75°F), the fan shall start. Once space setpoint temperature is satisfied, the fan shall stop.
1. EF-2, serving elevator machine room.

C. The following fan shall be ON during occupied mode and OFF during unoccupied mode.
1. EF-3, first floor parking garage.

3.04 ELECTRICAL CABINET UNIT HEATERS (ECUH-1, 2)

A. Fan switch OFF/ON (hi-speed) and temperature sensor with thermistor mounted in units return air path shall be factory mounted and wired.

B. Fan and electric coil shall cycle on demand from unit mounted thermistor.

C. Thermal cutouts shall open the control circuit and disconnect power to the heating elements if overheating occurs.

D. Unit shall be enabled during winter mode and disabled during summer mode.

3.05 ELECTRIC UNIT HEATER (EUH-1)

A. Thermostat and summer/winter switch shall be factory-mounted and wired.

B. Thermostat shall cycle fan and fintube heating element on demand from unit mounted thermostat.

C. Thermal cutouts shall open the control circuit and disconnect power to the heating elements if overheating occurs.

3.06 ELECTRIC WALL HEATER (EWH-1, 2)

A. Thermostat shall be factory-mounted and wired.

B. Thermostat shall cycle fan and fintube heating element on demand from unit mounted thermostat.

C. Thermal cutouts shall open the control circuit and disconnect power to the heating elements if overheating occurs.

3.07 DUCTLESS AIR CONDITIONING UNIT (AC-1, CU-1)

A. The unit shall have a wired controller to perform input functions necessary to operate the system.

B. The controller shall consist of an ON/OFF switch, cool/dry fan selector, thermostat setting, timer mode, high/low fan speed and auto vane selector.

C. Indoor unit and outdoor unit shall cycle on demand cooling from unit mounted temperature sensor to maintain space temperature setpoint.

D. The outdoor unit shall be capable of operating down to 0°F with no reduction in capacity and -20°F with a slight reduction in capacity.

3.08 DUCTLESS HEAT PUMP (HP-2, CU-2)

A. The unit shall have a wireless controller to perform input functions necessary to operate the system.

B. The controller shall consist of a power ON/OFF switch, mode selector, temperature setting, timer control, fan speed select and auto vane selector.

C. Indoor and outdoor unit shall cycle on demand (heating or cooling) from unit mounted temperature sensor to maintain space temperature setpoint.

D. The outdoor unit shall be capable of operating down to -20°F without tripping off on low temperature.

3.09 DUCT FURNACE (DF-1)

A. Low voltage 2-stage duct thermostat shall cycle furnace burner (subject to furnace safety control circuit) to maintain minimum plenum temperature at 65°F.

B. The supply fan is activated directly through the furnace section contactors. Fan shall run continuously.

C. Intermittent Pilot Ignition: Solid state ignition control system ignites the pilot by spark during each cycle of operation. When pilot flame is proven, main burner valve opens to allow gas flow to burners. Pilot and burners are extinguished during off cycle.

D. Two stage gas valve: Provide two stages of heat 50% and 100% of rated input. Ignition is at low fire.

3.10 CHANGEOVER BYPASS VAV ZONING SYSTEM (RTU-1, 2 and 3, VAV-1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, and 17, BYPASS VAV BOXES AT EACH RTU)

A. System Description:
   1. The changeover/bypass VAV system shall provide temperature control of multiple comfort zones through the use of a constant volume single-zone HVAC unit. Variable air volume control shall be provided for each zone to maintain zone temperature within the heating/cooling setpoints. The system shall monitor the temperature and setpoints of the zones and automatically change the heat/cool mode of the HVAC unit to satisfy zone requirements. The system shall maintain proper airflow through the duct system and HVAC unit by bypassing air from the supply to the return duct as necessary to maintain the required static pressure needed in the system.
   2. The changeover/bypass VAV system shall have all ancillary devices, sensors and operating parameters viewable and editable from a central system panel or from a computer communicating either directly or remotely with the DDC central control panel.
   3. Direct Digital Control (DDC) technology shall be used to provide the functions necessary for control of mechanical systems on this project.
      a. Manufacturer; company specializing in manufacturing VAV products of the type specified in this section with minimum 15 years documented experience.

B. System responsibility:
   1. The entire changeover/bypass system, including VAV terminal units, direct digital controls and building automation system shall be furnished by a single manufacturer who shall be responsible for the entire system. Acceptable manufacturers may either be the variable air volume terminal unit or temperature control manufacturer, but must bear sole responsibility for the system.

C. Warranty:
   1. Provide one year manufacturer's parts warranty from the time of start-up of the equipment.

D. Manufactured Units:
   1. Zone controls are ceiling mounted variable air volume supply air control terminals for connection to low pressure duct. VAV terminal units shall be networked to a central controller, which, based on the multiple zones comfort requirements, provides a staged "heat" or "cool" decision to be used by the building air conditioning unit. A variable air volume bypass air control terminal shall modulate to maintain a minimum air flow across the air conditioning unit.
   2. The systems controls shall be a dedicated direct digital microprocessor based control system with multi-level distributed microprocessing. System controls shall be designed for use exclusive to zone temperature and changeover/bypass control. General purpose or generic controls are not acceptable.

E. Wiring:
   1. Factory mount and wire VAV terminal unit controls. Mount electrical components in terminal unit control box with removable cover.
   2. Factory-mounted and tested actuator attached to casing and wired to control board.
   3. Provide industry standard 1/4" male spade connectors on terminal unit controller for field wiring of thermostat, communications and power source.
   4. All wiring shall comply with the local and national electric codes and the manufacturer's published installation manual.
   5. Provide terminal strips in central controller for field wiring of air conditioning unit input connections, communications, bypass damper motor and power wiring.

F. Controls:
   1. Zone temperature sensors:
      a. Sensor with thumbwheel setpoint adjustment night setback override and cancel buttons, and a communication jack.
      b. Sensor shall have digital display readout in °F, displaying either temperature or temperature setpoint night setback override and cancel buttons.
   2. Variable Air Volume (VAV) terminal unit controller:
      a. The VAV terminal unit controller shall be a microprocessor based, direct digital controller and shall contain the control logic required to modulate the flow of primary air through the terminal unit in the response to the difference between zone temperature and the appropriate setpoint. The terminal unit controller shall be capable of operating as a cool supply air controller or to "changeover" and operate as a warm supply air controller. The control algorithm shall be proportionally integral.
      b. All VAV terminal unit controller setpoints and operating parameters shall be stored in non-volatile electronic memory. Battery back-up is not acceptable.
      c. All VAV terminal unit controllers will come with factory programmed setpoints and operating parameters, or have default settings capable of providing typical operating control on power-up.
      d. The VAV terminal unit controller shall be field or factory configurable to function as an auto-changeover device, or as an auto-changeover device with a local heat control capability.
      e. The auto-changeover terminal unit controller shall control damper position, and therefore primary air flow, in response to zone temperature.
      f. The terminal unit controller shall be capable of operating as a cool supply air controller or to "changeover" to operate as a warm supply air controller.

g. The terminal unit controller shall be capable of controlling local heat, remote from the air conditioning unit heat, in response to a difference between zone temperature and the appropriate setpoint (VAV-17 is equipped with two stage electric heating coil).

3. Central Controller Base Panel:
   a. Upon central controller system panel power-up, all connected VAV terminal unit controllers, building system controller, unit HVAC machine, shall automatically identify themselves over the communication links.
   b. The following capabilities for each VAV terminal unit controller and the unit HVAC machine shall be viewable at the central controller and editable.
      (1) initiating timed override for extended occupied operation for the unit HVAC machine for a fixed time interval.
      (2) Enable, disable, or limit the range of the setpoint indicator on the zone thermostat sensor
      (3) Allow the operator to custom name devices
      (4) Detailed equipment status shall be available with no end-user programming. Points available are:
         (a) Operating mode
         (b) Operating status
         (c) Supply air temperature
         (d) Zone temperatures
         (e) Bypass position
         (f) Supply fan status
         (g) Fan static pressure
         (h) Fan static pressure setpoint
         (i) Total cool requests
         (j) Total heat requests
         (k) Time to system mode changeover
         (l) Compressor #1 status
         (m) Compressor #2 status
         (n) Heat stage #1 status
         (o) Heat stage #2 status
         (p) Worst zone deviation
         (q) Economizer status
         (r) Outside air damper position
         (s) Outside air temperature
   c. The central controller shall exchange information with each terminal unit controller. The information shall be electronically encoded and serially transmitted on single twisted pair communication link.
   d. Power shall be 24V, 50/60 Hz. The control system shall contain its own on-board isolation transformer or a dedicated transformer shall be provided. Operating temperature range shall be 32°F to 120°F. Operating humidity range shall be 10% to 90% non-condensing.
   e. The central controller shall send setpoints and override instructions to the terminal unit controller. The terminal unit controller shall send operating status and configuration information to the central controller.
4. The central controller shall be equipped to provide the following features:
   a. Communicate with up to 24 terminal unit controllers.
   b. Scan the terminal unit controllers to determine deviation from the temperature setpoint, time of deviation, and time from last changeover.
   c. Monitor system supply air temperature to ensure high/low limits are maintained
   d. Modulate position of the bypass damper based on supply air duct pressure input on the bypass damper controller to maintain minimum air flow through rooftop unit.
   e. Recalibration of the supply air duct pressure sensor upon system start-up.
   f. All central controller setpoints and operating parameters shall be stored in non-volatile electronic memory.
   g. Built-in seven day time clock.

h. Communicate with a computer software program for system start-up, normal operation and balancing.
i. Issuing override commands to terminal unit controllers.
j. Assigning terminal unit controllers into groups.
k. Reporting system status information.
l. Capable of interfacing via serial communications link with high end building automation system.
m. Shall have a single red flashing LED for indicating alarm conditions.
n. Discharge air control with limits.
o. Priority shutdown.
p. Two stage heat, two stage cooling capability.
q. Allow operator to enter occupied/unoccupied heating cooling setpoints for each terminal unit controller.
r. Time-of-day scheduling capability.
s. Failure mode operations sequence.
t. Capability of directly controlling the operation of a packaged gas fired rooftop unit with a factory installed microprocessor control board. The following points shall be monitoried:
(1) Operating mode/status
(2) Supply air temperature
(3) Zone temperature
(4) Bypass position
(5) Supply fan status
(6) Fan static pressure
(7) Total cool request
(8) total heat request
(9) Time to system mode changeover
(10) Controller status
(11) Worst zone status
(12) Outside air damper position
(13) Outside air temperature
(14) Economizer status.

5. Computer Software:
a. There shall be computer software available to allow the user complete access to the control panel by using the computer's serial card port.
b. There shall be computer software available to allow the user complete access to the control panel by using the modem in the computer to communicate with an external modem on the control panel.
c. System graphics: The software shall be graphically oriented. Provide a method for the operator to easily move between graphic displays.

3.11 INTERFACE WITH FIRE ALARM SYSTEM

A. The automatic temperature control (ATC) system shall monitor an output contact from the fire alarm system to indicate a fire alarm condition. Wiring from the fire alarm panel to the ATC system panel shall be provided under division 16. Final connection of wiring to ATC panel shall be under this section.

B. Upon receipt of a signal indicating a fire alarm condition, the ATC system shall command all air handling units off.

C. When fire alarm system is reset, control of air handling units shall return to normal operating mode.

3.12 SPACE TEMPERATURE SENSOR OVERRIDE

A. Space temperature sensors shall be provided with override buttons which, when depressed during unoccupied time periods, will override the zone's temperature controls and setpoints to occupied conditions for a user adjustable period of time (initially set for 2 hours).

3.13 GENERAL

A. ATC setpoints, reset schedules, time programs, historical trends shall be displayable at local ATC panels and on the systems operator workstations.

3.14 CHANGEOVER/BYPASS VAV SYSTEM

A. Manufacturer shall perform 100% functional test at the factory when fabrication of equipment is complete. The test shall assure successful operation of damper stroke, sensor inputs and communications.

END OF SECTION