

SECTION 29 0000

AUTOMATIC TEMPERATURE CONTROLS (ATC)

PART 1 - GENERAL

1.1 SCOPE

- A. The Division 29 shall work directly for the general contractor. The actual cost of the Division 29 will be negotiated by the University with the selection of the Division 29 in accordance with the terms and conditions of the campus IDIQ (indefinite delivery, indefinite quantity) contract for Division 29. The Division 29 Contractor will provide the chilled water, heating water, water and gas meters through the campus IDIQ contracts for these meters. The Division 29 Contractor shall furnish and install a complete automatic temperature control system including all field equipment, DDC panels, nit controllers, and central control equipment. The Division 29 Contractor shall be responsible for providing as many global controllers as are required to accomplish specified sequences of operation, including schedules and trending, while using a maximum of 90% memory capacity. System shall provide for the automatic control and monitoring of the following systems and equipment: energy recovery units, air handling units, chilled water system, heating water system, fan coil units, terminal boxes, miscellaneous alarms, and other equipment as indicated on the Drawings.
- B. The Division 29 Contractor shall be responsible for the controls system design, submittal documents, equipment, materials (including conduit, wire installation, termination, and tagging) supervision of the control equipment and material installation, programming, graphics and check-out. The Division 29 Contractor shall be responsible for a portion of the commissioning work. The commissioning work coordination shall be allocated between the Division 29 Contractor, mechanical contractor, electrical contractor, and the tab contractor and commissioning agent. All equipment and software shall be the most recent technology released by the manufacturer.

1.2 COORDINATION

- A. Air Handling Units.
1. Refer to Control Diagram for coordination between AHU Equipment and this specification.
 2. Damper end switches are specified in this Specification.
 3. Variable frequency drives for unit supply fan is furnished by ATC Contractor.
 4. Power wiring and conduit are specified in Division 26 - Electrical Specifications. Control and interlock wiring between fan motors and variable frequency drives are provided with unit packaged controls. Refer to Division 26 for requirements.
 5. Air handling unit shall be furnished with filters. Filters shall be furnished with magnehelic air gauges for each filter bank. Magnehelic air gauges shall be factory installed by the air handling unit manufacturer. Differential pressure transmitters for monitoring filter loading are specified in this Specification.
 6. Duct mounted smoke detectors are specified in Division 28. Wiring from smoke detectors to fire alarm panels are specified in Division 28. Fire alarm panels are specified in Division 28. Fire alarm system shall be furnished with a programmable relay for air handling unit safety shutdown purposes. Fire alarm contractor shall program the relay such that their normally closed contacts open in the event of an alarm condition (anywhere in the building). Relay shall be labeled "Air Handling Unit Fire Alarm". Control wiring from fire alarm panel relay to air handling unit variable frequency drives are specified in Division 28. Programming and control or air handling unit controls shall be by provided by this division.

B. Communications Cabling

1. Communications Cabling: Conduit (where specified), cabling for EMS trunk, EMS switchgear interface, and EMS LAN are specified in this section. Refer to Division 27 for requirements.
2. Campus network cabling to building will be installed by Electrical Contractor under Division 27. Campus network IT infrastructure shall be furnished and installed by Owner. Network cabling from designated network port to EMS switchgear shall be furnished and installed by Division 27.

C. Chilled Water System

1. Flow meter is specified in this Specification. The Automatic Temperature Control System Sub-Contractor shall furnish the flow meter to the Mechanical Contractor for installation.
2. Sensors and stainless wells for temperature sensors connected to the automatic temperature control system are specified in this Division. The Automatic Temperature Control System Sub-Contractor shall furnish the wells to the Mechanical Contractor for installation.
3. Water differential pressure transmitters are specified in this Specification. The Mechanical Contractor shall furnish the pipe taps and provide copper tubing to the water differential pressure transmitters. ATC contractor shall install the transmitter.
4. Pipe flanges for matching flow meter flanges are specified and installed in Division 23.
5. Variable frequency drives for chilled water pumps are furnished by ATC Contractor. Control and interlock wiring for chilled water pump drives are specified in this section. Refer to Division 26 for requirements.
6. Power wiring and conduit are specified in Division 26. Control, interlock wiring, and conduit are specified in this Section.

D. Heating Water System

1. Flow meters are specified in this Specification. The Automatic Temperature Control System Sub-Contractor shall furnish the flow meters to the Mechanical Contractor for installation.
2. Sensors and stainless wells for temperature sensors connected to the automatic temperature control system are specified in this Division. The Automatic Temperature Control System Sub-Contractor shall furnish the wells to the Mechanical Contractor for installation.
3. Water differential pressure transmitters are specified in this Specification. The Mechanical Contractor shall furnish the pipe taps and provide copper tubing to the water differential pressure transmitters. ATC contractor shall install the transmitter.
4. Pipe flanges for matching flow meter flanges are specified and installed in Division 23.
5. Variable frequency drives for heating water pumps are furnished by ATC Contractor. Control and interlock wiring for heating water pump drives are specified in this section. Refer to Division 26 for requirements.
6. Power wiring and conduit are specified in Division 26. Control, interlock wiring, and conduit are specified in this Section.

- E. DDC Panels and Field Equipment Panels
1. Power wiring, conduit, control and interlock wiring for DDC Panels and Field Equipment Panels are specified in this section. Refer to Division 26 for requirements.
 2. Control transformers for 24 VAC power are specified in this Specification. 120 VAC power to control transformers are specified in Division 26.
 3. Panels and installation are specified in this Specification.
- F. Miscellaneous Alarms: Fire alarm panels are specified in Division 28. Fire alarm panel shall be furnished with a programmable relay for status indication to the automatic temperature control system. Fire alarm contractor shall program the relay such that its normally closed contacts open in the event of an alarm condition (anywhere in the building). Relay shall be labeled "Building Fire Alarm". Conduit, control and interlock wiring from relay to DDC Panels are specified in this Section. Refer to Division 28.
- G. ATC Contractor shall provide and install all conduit, fittings, junction boxes, control wiring under the requirements of the Division 26. Division 26 Contractor shall install all power wiring and conduit per Division 26. ATC Contractor shall install all material, including control panels and field hardware; except dampers, flow meters, valves, and temperature wells. Division 26 shall tag and terminate all ATC wiring per controls drawings. ATC Contractor shall provide a competent electrician to verify and/or repair end-to-end installation and termination of all equipment upon completion of installation. All work must meet with final inspection of ATC Contractor and Engineer.
- H. Power Wiring
1. Power wiring required for the automatic temperature control system shall be furnished and installed by the ATC Contractor unless otherwise noted on the drawings or in the specifications.
 2. Control transformers for 24 VAC power are furnished, installed, and wired by the ATC Contractor unless otherwise noted on the drawings or in the specifications.
 3. Power wiring to the DDC Control Panels shall be furnished and installed by the Electrical Contractor.
 4. Power wiring to the field equipment panels shall be furnished and installed by the Electrical Contractor.
 5. Power wiring to damper actuators and control valves shall be furnished and installed by the ATC Contractor.
 6. Power wiring to variable frequency drives from electrical panels and from variable frequency drives to motors shall be furnished and installed by the Electrical Contractor.
 7. Power wiring from electrical panels to motor starters and from motor starters to motors shall be furnished and installed by the Electrical Contractor.
- I. Motor Starters
1. Motor starters shall be furnished and installed by the Electrical Contractor.
 2. Motor starters shall be furnished with 120VAC control transformers, Hand-Off-Automatic switches, and auxiliary contacts.
 3. Power wiring from electrical panels to motor starter and from motor starter to motor shall be furnished and installed by the Electrical Contractor.
 4. Control and interlock wiring for motor starter to accomplish the sequence of operations indicated on the control drawings shall be furnished and installed by

the ATC Contractor.

- J. Variable Frequency Drives
 - 1. Variable frequency drives, not provided as integral part of other equipment, shall be furnished by the ATC Contractor.
 - 2. Refer to variable frequency drive section of this specification and the Variable Frequency Drive schedule on the drawings.
 - 3. Control and interlock wiring for variable frequency drives shall be furnished and installed by the ATC Contractor.
 - 4. Power wiring from electrical panel to variable frequency drives and from variable frequency drives to motors shall be furnished and installed by the Electrical Contractor.
 - 5. Variable frequency drives shall be installed by the Electrical Contractor.
- K. Control Dampers and Actuators
 - 1. Control dampers are furnished and installed by the Sheetmetal Contractor.
 - 2. Control damper actuators shall be furnished and installed by the ATC Contractor.
 - 3. Refer to drawings for quantities, sizes, and locations of control dampers.
- L. Fire Alarm System
 - 1. The fire alarm system including the panel, duct mounted smoke detectors, programmable relays, and associated wiring shall be furnished and installed by the Electrical Contractor.
 - 2. The fire alarm system shall be furnished with programmable relays for status indication to the automatic temperature control system for safety shutdown of the HVAC systems.
 - 3. The Fire Alarm Contractor shall mount and program the relays such that its normally closed contacts open in the event of an alarm condition.
 - 4. The Fire Alarm Contractor shall locate the programmable relays in the same room as the HVAC system to be controlled.

1.3 QUALITY ASSURANCE

- A. Materials and equipment shall be the products of manufacturers regularly engaged in the production and installation of temperature control systems. Materials and equipment shall be the manufacturer's latest standard design that complies with the specifications.
- B. All electronic equipment shall conform to the requirements of FCC Regulations, Part 15, Section 15, governing radio frequency and electromagnetic interference and shall be so labeled.
- C. All system components shall be designed to be fault tolerant. Components shall operate in a satisfactory manner and without damage at plus 10% to minus 15% rated voltage and plus 3% to minus 3% line frequency. All inputs and outputs shall be equipped with static, transient, and short-circuit protection.

1.4 SUBMITTALS

- A. General: Submittal documents shall include as a minimum the following information: catalog data sheets, written sequences of operation, valve schedules, system flow diagrams, wiring diagrams, bill of materials, point lists, and raceway riser diagrams. All information pertaining to a specific item of equipment or system shall be located on a single drawing to the extent practical.

- B. Catalog Data Sheets: Data sheets shall be clearly marked so as to indicate the specific characteristics of the equipment and devices to be furnished. Data sheets shall be marked with the appropriate equipment designations consistent with the diagrams and bill of materials.
- C. Diagrams: All wiring shall be numbered and identified with respect to final termination. Diagrams shall include the relevant sections of all packaged equipment control panels such that the exact nature of the interface between these panels and the temperature control system is indicated. Each device shall have a unique designation. The source (panel number and circuit number) of all power connections to the temperature control system shall be indicated based upon circuits described on the drawings.
- D. Sequences of Operation: Sequences of operation shall include references to the specific devices involved in the execution of the sequence including panel inputs and outputs, transducers, relays, valves, dampers, etc.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Powers of Arkansas – Siemens Apogee.
- B. Harrison Energy Partners – Johnson Controls Facilities Explorer.

2.2 COMMUNICATIONS NETWORK

- A. The design of the EMS communications network shall consist of a high performance peer-to-peer system designed in accordance with ASHRAE Standard 135 BACnet communication protocol.
- B. DDC panel controllers shall reside directly on the EMS trunk such that communications may be executed directly between devices.
- C. Network shall provide high-speed data transfer rates for alarm reporting, report generation, and the upload/download activities. Data transfer rates shall be sufficient such that an alarm occurring at any DDC Panel OR Controller is displayed at the EMS user front end within 5 seconds.
- D. Network shall provide for the automatic synchronization of real-time clocks, message and alarm buffering, and error detection.
- E. The EMS LAN shall communicate bi-directionally with the EMS trunk through the DDC panels for the transmission of global data.
- F. Communication speed at the Ethernet trunk level shall be a minimum of 10/100 Mbps. Communication speed at the EMS LAN level shall be a minimum baud rate of 38.4kbps.

2.3 FIELD EQUIPMENT

- A. Control Wiring: Control wiring shall be numbered at all terminations in accordance with the submitted diagrams. Control wiring specified in this section 29 shall be installed in EMT conduit except in concealed accessible locations.
- B. Damper End Switches: End switches for damper position verification shall be auxiliary switches included with electronic actuators or KELE TS-470 or Allen Bradley 802T-AP with 802T-W2 lever when used with pneumatic actuators or with actuators provided by others without self-contained auxiliary switches.
- C. Field Equipment Panels: All control components not required by function to be remotely located such as sensing devices and valves shall be installed in metal enclosures. Enclosures shall be lockable with a hinged front door. All wiring terminations shall be made at numbered terminal blocks. Nameplates shall be installed at all devices.
- D. Water Flow Meters and Transmitters, Level 1 meters

1. Level 1 meters shall be applicable to primary chilled water and hot water systems utilizing chilled or hot water from the Campus Central Plant systems.
 2. Furnish and install electromagnetic (MAG) flow meters equal to Rosemount Model 8705 with Model 8732 transmitter or Onicon F-3200 series with integral transmitter or Badger Meter M-2000 Series.
 3. All Level 1 metered primary chilled water applications shall be provided with an Onicon System-10-BAC BTU meter.
- E. Water Flow Meters, Level 2 Meters
1. Level 2 meters shall be applicable to secondary metering and all domestic water metering.
 2. Furnish and install turbine style flow meters equal to Onicon F-1100 series. No display is required for Level 2 and Deduct Meters.
- F. Relays:
1. Panel mounted relays shall be IDEC RH series with light indicator with coil voltages, contact arrangements, and contact ratings suitable for the application.
 2. DPDT relays shall be provided at a minimum. SPDT shall not be used.
- G. Sensors
1. Duct Mounted Temperature Sensors: Shall be Siemens QAM series (Powers) / JCI TE-6300 (HEP) per IDIQ contract. Averaging elements shall be of sufficient length to cover the duct cross sectional area. One foot of temperature sensing element shall be installed be three square feet of cross-sectional area.
 2. Pipe Mounted Temperature Sensors: Shall be Siemens 544-577 series (Powers) / JCI TE-6300 series (HEP) HEP equivalent device per IDIQ contract. Installed in wells; JCI TE-6300W series or equivalent per IDIQ contract.
- H. Static Pressure Sensing Lines: Static pressure sensing lines shall be 3/8-inch plastic tubing installed in 1/2" minimum EMT conduit. Transmitters shall be installed in field equipment panels.
- I. Switches
1. General Current Switches: Current switches for lighting and single speed motor status indication shall be Veris H-900 series (Powers) / JCI CSDSC series (HEP) with clamp style core (solid core is not acceptable). Current switches shall be self-calibrating and sized for the application specific current load.
 2. ECM Current Switches: Current switches for electronically commutated motors (ECM's) shall be JCI CSDECM series with clamp style core (solid core is not acceptable). Current switches shall be self-calibrating and sized for the application specific current load.
 3. VFD Current Switches: Current switches for variable frequency drives (VFD's) shall be Veris model H614. Current switches for VFD's shall only be applicable when specifically shown on drawings.
 4. Differential Pressure Switches: Differential pressure switches shall be used to provide dirty filter alarm indication. Switches shall be Siemens 141-0574 series (Powers) / JCI (PENN) P32 series (HEP) per IDIQ contract .
 5. Electric Pressure Switches: Shall be Siemens 265-10 series (Powers) / JCI V11 or V24 series (HEP) per IDIQ contract. Coil voltages shall be as required for the application.
 6. Electropneumatic Transducers: Shall be Veris EP2 series. Transducers shall be

provided with plastic cover plates for protection.

7. High Static Pressure Switches: Shall be Siemens 141-0575 (Powers) / Cleveland AFS-460 (HEP) per IDIQ contract with single contact. Utilize relays as necessary for multiple contact requirements.
8. Low Limit Temperature Switches: Low limit switch shall be installed in the mixed air sections of each air handling unit. Sensing elements shall be of appropriate length to sufficiently cover the duct cross-sectional area. Switches shall be Siemens 134-1504 (Powers) / JCI A70HA-1 (HEP) per IDIQ contract. One ft. of temperature sensing element shall be installed per one square ft. of cross-sectional area.
9. Pressure Electric Switches: Pressure electric switches for control air pressure, laboratory air, and laboratory vacuum monitoring shall be suitable for the application.

J. Control Transformers: Control transformers shall be suitable for the application. Transformers shall be JCI Y63 series or engineer approved equal. Transformers shall be factory furnished with circuit breakers.

K. Transmitters

1. Duct Mounted Humidity Transmitters: Shall be Siemens QFM (Powers) / JCI HE-6700 series (HEP) per IDIQ contract.
2. Building Pressure Transmitter: Shall be Veris PX3 series with digital display and have a range of 1.0 to -1.0" W.G. Transmitters shall be panel mounted.
3. Differential Pressure Transmitters: Shall be Veris PX3 series with digital display and have a range appropriate for the application. Transmitters shall be panel mounted.

Underfloor differential pressure transmitters shall be 0.0 to 0.1 inches w.g.

4. Static Pressure Transmitters: Shall be Veris PX3 series with digital display and have a range of 0 to 10" W.G. Transmitters shall be panel mounted.
5. Wet-Wet Differential Pressure Transmitters: Shall be Veris PW2 or PWR series with digital display.

L. Valves

1. Chilled Water Control Valves: Valves shall be modulating two-way type with adequate closeoff pressure for system. Valve shall have a maximum water pressure drop of 4 psig. Valve types, body material, and pressure rating shall be suitable for the application. Valves shall be Siemens / JCI VG1000 series ball style or engineer specified alternative, per IDIQ contract. Chilled water control valve actuators shall be modulating type, and shall be able to close off against the pump shut-off head or 1.5 times pump head.
2. Heating Water Control Valves: Control valves shall be modulating two-way or three-way blending type as indicated on the Drawings and have adequate closeoff pressure for system. Valve shall have a maximum water pressure drop of 4 psig. Valve types, body material, and pressure rating shall be suitable for the application. Valves shall be Siemens / JCI VG1000 series ball style or engineer specified alternative, per IDIQ contract.

M. Air Flow Measuring Station

1. Provide an airflow monitoring station, field installed in the outdoor air ductwork by the Mechanical Contractor, for direct measurement of ventilation air.

2. The airflow monitor shall be an array of individual sensors consisting of two individually wired, hermetically sealed bead and glass thermistors. The thermistors will be mounted in the sensor assembly and wired to a remote transmitter and display. The transmitter and display are capable of displaying airflow temperature, system status and configuration settings.
3. Each sensor assembly shall independently determine the airflow rate and temperature at each measurement point.
4. Airflow accuracy shall be +/- 3% of reading over the entire operating airflow range. Temperature accuracy shall be +/- 0.15 F over the entire operating range of -20 to 160 F.
5. The operating humidity range for each sensor probe shall be 0-99% RH (non-condensing). Each sensor probe shall have a UL listed plenum rated cable and terminal plug for connection to the remote mounted transmitter. The operating airflow range shall be from 0-5,000 feet per minute. Sensor configuration shall be determined by the factory for the application.
6. Approved manufacturers of outside airflow measuring stations are Air Monitor OAM II (Powers) / Ebtron Advantage 3 Gold Series model GTx116P+ (HEP) per IDIQ contract.

2.4 DDC PANELS (HARDWARE)

- A. DDC panels as shown on drawings shall include Siemens PX Modular and Compact Controllers (PXC) (Powers) / JCI FX80 (JACE) Supervisory Controller (HEP) per IDIQ contract. Controller shall be installed in a factory approved locking enclosure.

2.5 DDC PANELS (SOFTWARE)

- A. General: All necessary software to form a complete operating system shall be provided. The software programs specified in this section shall be resident in the DDC panel and shall not be dependent upon the workstation or any other device for execution. Upon restoration of normal power, the Controller shall evaluate the status of all equipment and controlled devices and execute changes as necessary to resume normal operations. Control programs shall be capable of incorporating data from any and all other BACnet and N2 controllers on the network (global points). Control programs shall also be capable of issuing commands to any device connected to any DDC panel or controller on the network.

2.6 CENTRAL PLANT CONTROLLERS (HARDWARE)

- A. General: Controllers shall be installed where indicated on the Drawings. Controllers shall have sufficient input/output point capacity to accommodate the indicated sequences of operation. Controller shall be Siemens PX Modular and Compact Controllers (PXC) (Powers) / JCI FX-PCA series Advanced Application Programmable Controller (HEP) per IDIQ contract, mounted in a factory approved locking enclosure.

2.7 GENERAL HVAC UNIT CONTROLLERS

- A. Controllers shall be installed where indicated on the Drawings. Controllers shall have sufficient input/output point capacity to accommodate the indicated sequences of operation. Controller shall be a JCI FX-PCA series Advanced Application Programmable Controller or JCI FX-PCG series General Purpose Programmable Controller mounted in a factory approved locking enclosure. The type of controller selected shall be based on the processing power, memory, and point capacity required for the application.

2.8 VARIABLE FREQUENCY DRIVES

- A. Acceptable Manufacturers: Drives shall be as manufactured by Yaskawa (Powers) / Danfoss (HEP) per IDIQ contract.

- B. Locations: Variable frequency drives shall be provided for the equipment indicated on the Drawings.
- C. Type: Drives shall be variable torque PWM type.
- D. Submittals: Include front and side views of enclosures with overall dimensions, weights, conduit entrance locations, and nameplate legends. Provide catalog sheets indicating voltage, controller size, and ratings. Include complete wiring diagrams.
- E. Enclosure: Drive enclosures shall be NEMA 1 with a hinged lockable door. Provide integral fused disconnect switch or circuit breaker on the line side.
- F. Mechanical Room Environment: Drives shall be suitable for installation in a mechanical room environment (0 - 104 F and 0 - 90% RH non-condensing).
- G. Operator Keypad and Display: Each drive shall be furnished with a keypad and display. Keypad must be removable. Keypad must utilize a minimum of 12 membrane keys with tactile feel. Display to be a minimum of 16 characters per line by 2 lines. Display shall be back lit with adjustable contrast. Keypad shall allow the drive to be manually started and stopped. Keypad shall allow the adjustment of all setpoints and parameters. Keypad shall allow the output frequency to be manually controlled. Keypad and display shall allow the indication of output frequency, diagnostic messages, output voltage, output current, motor data, setpoints, and control parameters.
- H. Diagnostics: Each drive shall be equipped for self-diagnostic operation including reference speed command, heat sink temperature, bus voltage, bus current, PWM frequency, I/O command status, software version, and control settings.
- I. EMS Interface: Each drive shall be equipped with a BACnet interface card for direct connection to and communication with the EMS Sub-network. Interface shall as a minimum provide the following functions:
 - 1. VFD Mode:
 - a. Hand
 - b. Off
 - c. Auto
 - d. Bypass
 - 2. Current Motor Speed (RPM)
 - 3. Current Motor Frequency (Hz)
 - 4. Current VFD control setpoint
 - a. Frequency (Hz)
 - b. Speed (RPM)
 - c. Control signal (0-100%)
 - 5. VFD Alarm
 - 6. Start - Stop Status
 - 7. Motor Status
 - 8. Output voltage each phase (V)
 - 9. Motor current each phase (A)
 - 10. Power output (KW)
 - 11. Power consumption (KWh)

12. Power factor
 13. VFD Minimum Frequency
 14. VFD Maximum Frequency
 15. VFD Current limit
 16. VFD Acceleration time
 17. VFD Deceleration time
 18. VFD Safety status
 19. Configuration parameters
- J. Speed Control: The output frequency of each drive shall be controlled by a 4-20 mA current signal or 0-10 VDC voltage signal from the DDC panel. Drives shall be programmed with seven minute ramp speed, subject to equipment requirements served.
- K. Ratings
1. Rated Input Voltage: Per contract drawings (e.g. 480 volts, 3 phase, 60 Hertz)
 2. Motor Nameplate Voltage: Per contract drawings
 3. Displacement Power Factor: Between 1.0 and 0.95, lagging, over entire range of operating speed and load.
 4. Minimum Efficiency at Full Load: 96%
- L. Control Wiring: Each drive shall be equipped with a 115 VAC control transformer with fuses. Drive shall be configured and equipped for an automatic restart after a power failure. Each drive shall be equipped with safety interlock and status contacts. Safety interlock terminals shall allow starting under both the automatic and manual modes of operation.
- M. Input Line Reactance: Each drive shall be equipped with input and output line reactance. Power line noise shall be limited to a voltage distortion factor and line notch depth as defined in IEEE Standard 519-1981, Guide for Harmonic Control and Reactive Compensation of Static Power Converters. Drives shall not emit either conducted or radiated RFI in excess of the limitations set forth in the FCC Rules and Regulations, Part 15, Subpart J.

PART 3 - EXECUTION

3.1 SEQUENCES OF OPERATION: Sequences of operation for each item of equipment and system are indicated on the Drawings.

3.2 PROGRAMMING

- A. General: DDC panels and controllers shall be programmed to provide the indicated sequences of operation. Selection of control mode (P, PI, or PID) shall be based upon the specific devices involved such that the process variables are restored and maintained at the desired level without offset in a responsive and stable manner. Programs shall be written in such a manner that all systems and equipment shall default to a safe operation or position in the event of a hardware, communication, or software failure.
- B. Energy Management Programs: Energy management programs shall be implemented where indicated in the sequences of operation.
- C. Custom Programs: Custom programs for equipment specific processes shall be implemented where indicated in the sequences of operation.
- D. Central Equipment Programming: Central equipment programming shall include data base generation, system initialization, weekly schedules, analog limits, change-of-state

messages, point groups, color graphic displays, and alarm messages. Color graphic displays shall be generated for the entire network, steam system, chilled water system, domestic water heating system, heating water system, energy recovery air handling units, exhaust fans, floor plans, air terminals, blower coils, and fan coil units.

- E. Program Documentation: Documentation in the form of a flow chart and a detailed program listing with English language descriptors shall be provided for each process. These documents shall be placed in binders located at each DDC panel and at the operator workstation. Program information shall be protected from the environment by plastic laminate or sleeves.

- 3.3 **TESTING:** When the installation of the system is complete, the Contractor shall execute the following field tests: verify transmission media operation, calibrate all temperature sensors, verify local control and stand-alone operation, and verify proper operation of each control point. The Contractor shall also provide to the Engineer for review and approval trend data each 30 minutes for a 72 hour period for all points served by the automatic temperature control system installed under this Contract. Data shall be provided in Microsoft Excel format on CD's. Contractor shall also provide the telephone modem number, and system password access to the Engineer as required to allow independent verification of system performance. System shall be installed to allow standard, over the counter, software to be utilized to remotely monitor the system. This software shall be the responsibility of the engineer to provide. This contractor shall offer up to 8 hours assistance in the setup and training of use of this software.
- 3.4 **TESTING, ADJUSTING AND BALANCING ASSISTANCE:** The Automatic Temperature Controls Sub-Contractor shall provide up to 40 hours of assistance to the Testing, Adjusting, and Balancing (TAB) Contractor. If additional assistance is required, the TAB Contractor can purchase this time at the standard UAF IDIQ Rate.
- 3.5 **COMMISSIONING ASSISTANCE:** The Automatic Temperature Controls Sub-Contractor shall provide up to 80 hours of assistance to the Commissioning Agent. The Commissioning Agent shall be selected and compensated directly by the Owner. If additional assistance is required, the Commissioning Agent can purchase this time at the standard UAF IDIQ Rate. Refer to Section 01810 for all commissioning requirements.
- 3.6 **GUARANTEE:** Contractor shall provide all services, materials, and equipment necessary for the successful operation of the control system for a period of one year after substantial completion. Work shall include all scheduled maintenance requirements including adjustments, diagnostics, software updates, and calibration. Scheduled maintenance shall be performed during a minimum of 4 quarterly visits. Response time to the site for unscheduled maintenance shall be not more than 24 hours during normal business working hours. After hour calls are not included. Contractor shall furnish and install all software updates released within the warranty period.
- 3.7 **RECORD DRAWINGS:** Contractor shall maintain accurate record drawings of the work. A copy of the record drawings (control diagrams and sequences of operation) shall be laminated and mounted at each DDC Panel.
- 3.8 **TRAINING:** Contractor shall fully instruct the Owner's maintenance personnel in the proper operation and maintenance of the installed equipment and systems. Training shall be provided in a classroom format with written literature for up to 5 participants. Training times shall be scheduled in advance with the Owner. Training shall address as a minimum the following topics: control diagrams, catalog data, and maintenance manuals, walk-through of project to inspect control components, thorough review of operator workstation, portable operator's terminal, DDC panel and controller functions, color graphic displays, and explanation of scheduled maintenance requirements including adjustment, calibration, and replacement procedure. Instructor training shall be 24 hours in duration.

END OF SECTION