

**SECTION 23 0923  
DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC**

**PART 1 GENERAL**

**1.01 DESCRIPTION OF WORK**

- A. This specification is intended for reference only. The Owner will furnish all Invensys Climate Control (aka Schneider Electric: IA Series), control devices and wiring that is included in this section by OGS/GSA contract. The Mechanical Contractor will be responsible for contracting with the temperature controls provider for wiring, programming, commissioning, etc. The Mechanical Contractor shall also be responsible for installing control components in the piping and duct work systems, such as but not excluding the following: Automatic Control Dampers, Automatic Control Valves, Temperature Sensing Thermal Wells and Pressure Control Sensing Taps The Temperature Controls Contractor (TCC) shall be a factory trained and authorized Invensys Climate Control, Dealer Office. (Stark "TBS Controls")
1. This project is a design make Invensys Climate Control System. See section 2.1 of this specification for Acceptable Manufacturers.
  2. Furnish all labor, materials, equipment, and service necessary to provide a complete and operating temperature control system. System shall use Direct Digital Controls, electronic interfaces and actuation devices, as shown on the drawings and as described herein. Control sequences are specified in this section.
    - a. All actuation of valves and dampers shall be electric unless specifically called out elsewhere in the specifications or drawings.
  3. The Building Automation System (BAS) shall have the following capabilities as described in these specifications:
    - a. The Network Control Units (NCU)(s) and Computer(s) shall be connected directly to the Owners Ethernet Network.
    - b. If existing, off site access for Owner's personnel shall be extended to include new work herein. Identical graphical displays shall be provided for offsite access to match the displays at the on-site Operator Workstation. Connection to the site shall be via a high speed Ethernet connection. The contractor shall coordinate with the Owners IT professionals for high speed system access and shall comply with Owners requirements to maintain the level of security required by the Owner.
    - c. The BMS network controller shall integrate into the existing Invensys Climate Control server.
    - d. All system variables in the BMS system shall be Microsoft variables allowing them to be display and manipulated in other Microsoft products.
    - e. Network controllers shall all be flash upgradeable and not require changing chips for upgrades.
    - f. Short term logging of historical data shall be provided for every DDC input and output in the system. Each point shall be logged for a minimum of 2 weeks.
- B. **QUALITY ASSURANCE**
1. All labor, material, equipment and software necessary to meet the functional intent of the system, as specified herein and as shown on the drawings, shall be provided by one of the manufacturers listed in Part 2 - Products. Equipment and labor not specifically referred to herein or on the plans, which are required to meet the functional intent, shall be provided without additional cost to the Owner. This contractor also is responsible for all costs of changes in the work required by substitute equipment.

2. The Building Management System (BMS) Contractor must have been in business for not less than 10 years, and providing BMS systems must be the Contractors primary business. BMS Contractor must be an authorized dealer office of the manufacturers specified. BMS Contractor must have a trained staff of application engineers, project managers, software engineers, commissioning staff, and service staff experienced in the configuration, programming and service of the automation system.
3. The BMS Contractor shall have a training facility with regularly scheduled training as outlined in Section 1.4 so as to provide ongoing regularly scheduled application training.
4. Manufacturer: A firm regularly engaged in manufacture of microprocessor temperature control equipment, of types and sizes which are similar to required equipment, and which have been in satisfactory use for not less than 10 years, in similar service.
5. Electrical standards: Provide electrical products that comply with the following agency approvals:
  - a. UL-916; Energy Management Systems for BAS components and ancillary equipment
  - b. UL-873; Temperature Indication and Regulating Equipment
  - c. FCC, Part 15, Subpart J, Class A Computing Devices
6. All products shall be labeled with the appropriate approval markings. System installation shall comply with NFPA, NEMA, Local and National codes.

C. SCOPE OF WORK

1. Except as otherwise noted, the control system shall consist of all Ethernet Network Controllers, Standalone Digital Control Units, workstations, software, sensors, transducers, relays, valves, dampers, damper operators and other accessory equipment, along with a complete system of electrical interlocking wiring as required to fill the intent of the specification and provide for a complete and operable system. Except as otherwise specified, provide operators for equipment such as dampers if the equipment manufacturer does not provide these. Coordinate requirements with the various Contractors.
2. The BAS contractor shall review and study all HVAC drawings and the entire specification to familiarize himself with the equipment and system operation and to verify the quantities and types of dampers, operators, alarms, etc. to be provided.
3. All interlocking, wiring and installation of control devices associated with the equipment listed below shall be provided under this Contract. When the BAS system is fully installed and operational, the BAS Contractor shall review and check out the system. At that time, the BAS contractor shall demonstrate the operation of the system to the Owner and prove that it complies with the intent of the drawings and specifications.
  - a. The Contractor shall furnish and install a complete building automation system including all necessary hardware and all operating and applications software necessary to perform the control sequences of operation as called for in this specification.
4. Provide services and manpower necessary for commissioning of system in coordination with the HVAC Contractor, Balancing Contractor and Owner's representative. Commissioning reports showing the testing of each DDC point on the system shall be submitted to the Engineer for review and approval upon completion of the commissioning process. See Section 3.6 Commissioning and System Startup section for detail.
5. All work performed under this section of the specifications shall comply with all codes, laws and governing bodies. If the drawings and/or specifications are in conflict with governing codes, the Contractor shall submit a proposal with appropriate modifications to the project for code compliance. If this specification and associated drawings exceed governing code requirements, the specification shall govern. The Contractor shall obtain and pay for all necessary construction permits and licenses.
6. All 120V power circuitry required for control devices shall be by the BAS contractor in accordance with DIVISION 26 specifications.

#### D. TRAINING

1. The BAS Contractor shall provide both on-site and classroom training to the Owner's representative and maintenance personnel per the following description:
  - a. On-site training shall consist of a minimum of (4) hours of hands-on instruction geared at the operation and maintenance of the systems. The curriculum shall include:
    - 1) System Overview
    - 2) System Software and Operation
      - (a) System access
      - (b) Software features overview
      - (c) Changing setpoints and other attributes
      - (d) Scheduling
      - (e) Editing programmed variables
      - (f) Displaying color graphics
      - (g) Running reports
      - (h) Workstation maintenance
      - (i) Application programming
    - 3) Operational sequences including start-up, shutdown, adjusting and balancing.
    - 4) Equipment maintenance.
2. Classroom training shall include a minimum of (1) training slot for two days of course material covering workstation operation and controller programming. The cost for travel and lodging shall be included in this contract if Training Center is more than 150 miles from the Project Site.
3. The training facility shall have the capability to provide hands on training experience for all applications that can be run on the Invensys Climate Controls application.

#### E. SYSTEM DESCRIPTION

1. The Building Automation System (BAS) shall consist of existing PC-based workstation and microcomputer controllers of modular design providing distributed processing capability, and allowing future expansion of both input/output points and processing/control functions.
2. For this project the system shall consist of the following components:
  - a. Ethernet-based Network Controller(s): The BAS Contractor shall furnish (1 or more) Ethernet-based network controllers as described in Part 2 of the specification. If the existing controller is sufficient to include the new work, a new controller is not required. These controllers shall connect directly to the Operator Workstation over Ethernet, provide communication to the Standalone Digital Control Units and/or other Input/Output Modules and serve as a gateway to equipment furnished by others (if applicable).
  - b. Standalone Digital Control Units (SDCUs): Provide the necessary quantity and types of SDCUs to meet the requirements of the project for mechanical equipment control including air handlers, central plant control, and terminal unit control. Each SDCU shall operate completely standalone, containing all of the I/O and programs to control its associated equipment.
  - c. A high speed Ethernet connection to the school shall be furnished by the school district. BMS contractor shall coordinate with the Owners IT professionals and comply with the Owner's IT professionals requirements.

#### F. WORK BY OTHERS

1. The BAS Contractor shall cooperate with other contractors performing work on this project necessary to achieve a complete and neat installation. To that end, each contractor shall consult the drawings and specifications for all trades to determine the nature and extent of others' work.

2. The BAS Contractor shall furnish all control valves, sensor wells, flow meters and other similar equipment specified in this section for installation by the Mechanical Contractor.
3. The BAS Contractor shall provide field supervision to the designated contractor for the installation of the following:
  - a. Automatic Control Dampers
  - b. Automatic Control Valves.
  - c. Temperature Sensing Thermal Wells
  - d. Pressure Control Sensing Taps

#### G. WARRANTY AND ACCEPTANCE

1. The microprocessor temperature control contractor shall warrant the control system installed in this contract to be free from defects in material and workmanship, except for damages from other causes, for a period of one year after final acceptance from the owner. The microprocessor temperature control contractor shall be responsible for all necessary revisions to the software required for a workable system performance through the first year of operation. Any changes in the software shall be transmitted immediately to the owner. The software responsibility is for a complete and workable system as described in the control cycle description of the specification. The software shall become the property of the owner.
2. Updates to the manufacturer's software shall be provided at no charge during the warranty period, unless otherwise purchased by the District under a service agreement.
3. All equipment required to maintain operation of the temperature control system for the project shall be stocked in the microprocessor temperature control contractor's local facility. It shall be immediately available in the event of component failure. A spare or loaner piece of equipment shall be installed immediately when a failure occurs and the equipment shall be returned to the factory for repair.

#### H. SUBMITTALS

1. Shop drawings shall include a riser diagram depicting locations of all controllers and workstations, with associated network wiring. Also included shall be individual schematics of each mechanical system showing all connected points with reference to their associated controller. Typical schematics will be allowed where appropriate.
  - a. Each drawing containing an equipment schematic shall contain a table indicating what equipment is covered by this drawing (i.e. equipment "tag #") and which drawing in the Construction Document set this piece of equipment is shown on.
2. Submittal data shall contain manufacturer's data on all hardware and software products required by the specification. Valve, damper and airflow station schedules shall indicate size, configuration, capacity and location of all equipment.
3. Software submittals shall contain narrative descriptions of sequences of operation, program listings, point lists, and a complete description of the graphics, reports, alarms and configuration to be furnished with the workstation software. Information shall be bound or in a three ring binder with an index and tabs.
4. Submit five (5) copies of submittal data and shop drawings to the Engineer for review prior to ordering or fabrication of the equipment. Prior to submitting, the Contractor shall check all documents for accuracy.
5. The Engineer will make corrections, if required, and return to the Contractor. The Contractor shall then resubmit with the corrected or additional data. This procedure shall be repeated until all corrections are made to the satisfaction of the Engineer and the submittals are fully approved.

6. Each point in the system shall be tested for both hardware and software functionality. In addition, each mechanical and electrical system under control of the BAS shall be tested against the appropriate sequence of operation specified herein. Successful completion of the system test shall constitute the beginning of the warranty period. A written report shall be submitted to the owner indicating that the installed system functions in accordance with the plans and specifications.
  7. The BAS contractor shall commission and set in operating condition all major equipment and systems, such as the hot water and all air handling systems, in the presence of the equipment manufacturer's representatives, as applicable, and the Owner and Architect's representatives. See Section 3.6 for detail required in Commissioning the system.
  8. The BAS Contractor shall provide all manpower and engineering services required to assist the HVAC Contractor and Balancing Contractor in testing, adjusting, and balancing all systems in the building. The BAS Contractor shall have a trained technician available on request during the balancing of the systems. The BAS Contractor shall coordinate all requirements to provide a complete air balance with the Balancing Contractor and shall include all labor and materials in his contract.
- I. OPERATING AND MAINTENANCE MANUALS
1. The operation and maintenance manuals shall contain all information necessary for the operation, maintenance, replacement, installation, and parts procurement for the entire BAS. This documentation shall include specific part numbers and software versions and dates. A complete list of recommended spare parts shall be included with the lead-time and expected frequency of use of each part clearly identified.
  2. Following project completion and testing, the BAS contractor shall submit as-built drawings reflecting the exact installation of the system. The as-built documentation shall also include a copy of all application software in written form.

## **PART 2 - PRODUCTS**

### **2.01 ACCEPTABLE MANUFACTURERS**

- A. Manufacturer - Provide the following microprocessor control system:
1. Schneider Electric IA Series. All control devices shall be purchased by the Owner and installed by the Temperature Controls Contractor (TCC). The TCC shall be a factory trained and authorized Invensys Climate Control, factory dealer office.
- B. SYSTEM ARCHITECTURE
1. The Building Management System (BMS) shall consist of Network Area Controllers (NACs), a family of Local Controllers, Existing Operator Workstations (OWs), and a File Server to support system configurations where more than three operator workstations are required. The BMS shall provide control, alarm detection, scheduling, reporting and information management for the entire facility, and Wide Area Network (WAN) if applicable, from a single ODBC-compliant SQL database. The system shall be designed with a top-level 10/100bT Ethernet network, using ISO 8802-3 data link/physical layer. A sub-network using the RS-485 token passing protocol, with a minimum of 19.2kb speed, shall connect the local, stand-alone controllers with Ethernet-level controller/routers.
  2. Level 1 Network Description: Level 1, the main backbone of the system, shall be an ISO 8802-3, 10/100bT LAN/WAN, using Ethernet as the communications protocol. Network Area Controllers, Operator Workstations, and Servers shall connect directly to this network without the need for Gateway devices.
  3. Level 2 Network Description: Level 2 of the system shall consist of one or more local Controllers. Minimum speed shall be 19.2kbps. The Level 2 field bus consists of an RS485, BACnet MSTP bus that supports 40-60 Local Controllers to operate HVAC equipment, lighting, power metering and monitoring, fuel tank monitoring, UPS battery and generator monitoring, smoke and fire detection, water leak detection, and video surveillance and access control.

4. BMS LAN Segmentation: The BMS shall be capable of being segmented, through software, into multiple local area networks (LANs) distributed over a wide area network (WAN), sharing a single file server. This enables workstations to manage a single LAN (or building), and/or the entire system with all devices being assured of being updated by and sharing the most current database. In the case of a single workstation system, the workstation shall contain the entire database – with no need for a separate file server.
  5. Standard Network Support: All NACs, Workstations and Servers shall be capable of residing directly on the owner's Ethernet TCP/IP LAN/WAN with no required gateways. Furthermore, the NACs, Workstations and Servers shall be capable of using standard, commercially available, off-the-shelf Ethernet infrastructure components such as routers, switches and hubs. With this design the owner may utilize the investment of an existing or new enterprise network or structured cabling system. This also allows the option of the maintenance of the LAN/WAN to be performed by the owner's Information Technology (IT) Department as all devices utilize standard TCP/IP components.
  6. System Expansion: The BMS shall be scalable and expandable at all levels using the same software interface and the same Level 1 and Level 2 controllers. Systems that require replacement of either the workstation software or field controllers in order to expand the system shall not be acceptable.
    - a. The BMS shall be expandable to include Video Surveillance and Access Control functions at any time in the future without requiring additional workstations, or Level 1 controllers. Biometric readers, keypads or proximity card access controllers shall be able to be added to the existing Level 1 network, to perform security and access control applications. In this way, an owner's existing investment in wiring infrastructure may be leveraged and the cost and inconvenience of adding new field bus wiring can be minimized.
    - b. Additional web-based operator licenses shall be added in the field through an upgrade of the web server's security key, with no re-programming required.
  7. Support for Open Systems Protocols: The BMS design must include solutions to integrate the following open system protocols: BACnet, Modbus, and digital data communication to third party microprocessors such as chiller controllers, smoke, fire and life safety panels and variable frequency drives (VFDs) – as required to complete the work.
- C. NETWORK CONTROL UNITS (NCUs) – Invensys Climate Control, controllers are basis of design
1. General: Upgrade existing NCU's to the latest version and software revision.
- D. LOCAL CONTROLLERS – Invensys Climate Control, controllers are basis of design.
1. General: Local Controllers shall provide control of HVAC, CRAC units, lighting, power metering, electrical monitoring, UPS, and leak detection. This may include air handling units, rooftop units, variable air volume boxes, unit ventilators, smoke, fire and life safety systems, and other mechanical equipment. Each controller shall be fully programmable, contain its own control programs and will continue to operate in the event of a failure or communication loss to its associated NAC.
  2. Hardware Specification:
    - a. Memory: Both the operating system of the controller, plus the application program for the controller, shall be stored in non-volatile, flash memory. Controllers shall contain enough memory for the current application, plus required history logging, plus a minimum of 20% additional free memory.
    - b. Communication Ports: Local Controllers shall have a RS-485 communication port field bus, operating at a speed of at least 19.2kbps.
    - c. Input/Output: Each local Controller shall have enough inputs and outputs to meet the application's required point count. Each local controller shall support universal inputs, whereas any input may be software-defined as:
      - 1) Digital Inputs for status/alarm contacts

- 2) Counter Inputs for summing pulses from meters.
  - 3) Thermistor Inputs for measuring temperatures in space, ducts and thermowells.
  - 4) Analog inputs for pressure, humidity, flow and position measurements.
  - d. Local controllers must support both digital and analog output types:
    - 1) Digital Outputs for on/off equipment control.
    - 2) Analog Outputs for valve and damper position control, and capacity control of primary equipment.
  - e. Expandability: For larger controllers (16 base inputs and up), provide input and output expansion through the use of plug-in modules. At least two I/O modules must be capable of being added to the base Local Controller.
  - f. Networking: Each local controller will be able to exchange information on a peer to peer basis with other Interoperable Digital Controller. Each local controller shall be capable of storing and referencing global variables (on the LAN) with or without any workstations online. Each local controller shall be able to have its program viewed and/or enabled/disabled through a workstation connected to an NAC.
  - g. Indicator Lamps: Local Controllers will have as a minimum, LED indication of CPU status, and field bus status.
  - h. Real Time Clock (RTC): All Local Controllers shall have a real time clock in either hardware or software. The accuracy shall be within 10 seconds per day. The RTC shall provide the following information: time of day, day, month, year, and day of week. Each Local Controller shall receive a signal, every hour, over the network from the NAC, which synchronizes all Local Controllers real time clocks.
  - i. Automatic Restart after Power Failure: Upon restoration of power, the Local Controller shall automatically and without human intervention, update all monitored functions, resume operation based on current, synchronized time and status, and implement special start-up strategies as required.
  - j. Battery Back Up: All Local Controllers shall store all programming in non-volatile flash memory. All Local Controllers except terminal controllers shall include an on-board lithium battery to back up the controller's RAM memory. The battery shall have a shelf life of over 10 years, and provide accumulated backup of all RAM and clock functions for at least 3 years. In the case of a power failure, the Local Controller shall first try to restart from the RAM memory. If that memory is corrupted or unusable, then the Local Controller shall restart itself from its application program stored in its flash memory.
3. Software Specification:
- a. General: The Local Controller shall contain flash memory to store both the resident operating system AND the application software. There will be no restrictions placed on the type of application programs in the system. Each Local Controller shall be capable of parallel processing, executing all control programs simultaneously. Any program may affect the operation of any other program. Each program shall have the full access of all I/O facilities of the processor. This execution of control function shall not be interrupted due to normal user communications including interrogation, program entry, printout of the program for storage, etc.
  - b. User Programming Language:
    - 1) The application software shall be user programmable. Controllers should be freely programmable. Fixed function controllers will not be accepted.
    - 2) Control Software, Mathematical Functions, and Energy Management Applications must be identical to that which is provided with the Network Area Controller.

- c. History Logging: Each controller shall be capable of locally logging any input, output, calculated value or other system variable over user defined time intervals ranging from 1 second to 1440 minutes. Any system can be logged in history. A minimum of 1000 values shall be stored in each log. Each log can record either the instantaneous, average, minimum or maximum value of the point. Logged data shall be downloadable to the Operator Workstation for long term archiving based upon user-defined time intervals, or manual command.
  - d. Alarm Management:
    - 1) For each system point, alarms can be created based on high/low limits or conditional expressions. All alarms will be tested each scan of the Local Controllers and can result in the display of one or more alarm messages or reports.
    - 2) Up to 8 alarms can be configured for each point in the controller.
    - 3) Alarms will be generated based on their priority. A minimum of 255 priority levels shall be provided.
    - 4) If communication with the Operator Workstation is temporarily interrupted, the alarm will be time-stamped and buffered in the controller. When communications return, the alarm will be transmitted to the Operator Workstation if the point is still in the alarm condition.
4. Air Handler Controllers
- a. AHU Controllers shall be capable of meeting the requirements of the sequence of operation found in the Execution portion of this specification and for future expansion.
  - b. AHU Controllers shall support all the necessary point inputs and outputs as required by the sequence and operate in a standalone fashion.
  - c. AHU Controllers shall be fully user programmable to allow for modification of the application software.
5. Unitary Controllers – Invensys Controllers
- a. Unitary Controllers shall support, but not be limited to, control of the following systems as described in the Execution portion of this specification, and for future expansion:
    - 1) Packaged Rooftops
  - b. The I/O of each Unitary Controller shall contain sufficient quantity and types, as required, to meet the sequence of operations found in the Execution portion of this specification. In addition, each controller shall have the capability for local time of day scheduling, occupancy mode control, after hour operation, lighting control, alarming, and trending.
- E. COMMUNICATIONS TO 3RD PARTY DEVICES
- 1. General: Where required, provide a Gateway to interface to that equipment that uses the Modbus protocol, or other proprietary or open protocols.
  - 2. Communication Ports: In addition to its on-board Ethernet port, the Gateway shall have at least two serial communications ports for interfaces to third-party systems.
  - 3. Memory: The Gateway shall have enough RAM memory to store all point configuration data, plus required history logging and alarm buffering. Minimum RAM shall be 8MB. The operating system of the gateway must be stored in flash non-volatile memory.
  - 4. User Programming Language:
    - a. The Gateway shall employ the same user programmable application software that NACs and Local Controllers use.
    - b. Control Software, Mathematical Functions, and Energy Management Applications must be identical to that which is provided with the Network Area Controller. Gateways that do not have an application programming language will not be accepted.

5. History Logging: Each Gateway shall be capable of locally logging any input, output, calculated value or other system variable over user defined time intervals ranging from 1 second to 1440 minutes. Any system can be logged in history. A minimum of 1000 values shall be stored in each log. Each log can record either the instantaneous, average, minimum or maximum value of the point. Logged data shall be downloadable to the Operator Workstation for long term archiving based upon user-defined time intervals, or manual command.
- F. WORKSTATIONS AND SOFTWARE – Upgrade Existing Invensys Climate Control as Required
- G. DDC SENSORS AND POINT HARDWARE
1. General: Where indicated on the drawings, schedules or sequence of operations, provide equipment that conforms to the following specifications:
  2. Temperature Sensors:
    - a. All temperature devices shall use precision thermistors accurate to +/- 0.36°F over a range of -30 to 230°F.
    - b. Standard space sensors shall be provided in an off white enclosure for mounting on a standard electrical box.
    - c. Where manual override of unoccupied mode of control is indicated on the drawings or sequence of operation, provide a push button for selecting after hours operation.
    - d. Duct temperature sensors shall incorporate a thermistor bead embedded at the tip of a stainless steel tube. Probe style duct sensors shall be used in air handling applications where the air stream temperature is consistent and is not stratified.
    - e. Averaging sensors shall be employed in all mixing plenum applications and in any other application where the temperature might otherwise be stratified. The averaging sensor tube shall contain at least four thermistor sensors.
    - f. Immersion sensors shall be employed for measurement of temperature in all chilled water, hot water and glycol applications. Thermal wells shall be brass or stainless steel for non-corrosive fluids below 250 degrees F and 300 series stainless steel for all other applications.
  3. Pressure Sensors:
    - a. Air pressure or differential air pressure measurements in the range of 0 to 10" water column shall be accurate to +/- 1% of range using a solid-state sensing element. The range of the instrument selected shall be 2 times the operating pressure of the sensed variable. Acceptable manufacturer shall be Setra model C-264.
    - b. Liquid pressure or differential liquid pressure measurements shall be accurate to +/- 0.25% of range using a solid-state sensing element. The range of the instrument selected shall be 2 times the operating pressure of the sensed variable. Unit shall be provided with isolation and bypass manifold for start-up and maintenance operations. Acceptable manufacturer shall be Setra model C-230.
  4. Low Limit Thermostats:
    - a. Safety low limit thermostats shall be vapor pressure type with a 20 foot minimum element. Element shall respond to the lowest temperature sensed by any one foot section. Provide one thermostat for each 25 square foot of coil area.
    - b. Low limit thermostat shall be manual reset and shall be double pole so as to provide input capability for alarm at the BAS.
  5. Current Sensing Status Switches
    - a. Current status switches shall be used to monitor the run status of fans, pumps, motors and electrical loads. Acceptable manufacturer is Veris or approved equal.
  6. Control Valves
    - a. Provide automatic control valves suitable for the specified controlled media (water or glycol). Provide valves that mate and match the material of the connected piping.

- b. Control valves shall meet the heating and cooling loads specified, and close off against the differential pressure conditions within the application. Valves should be sized to operate accurately and with stability from 10 to 100% of the maximum design flow. Valves shall be selected to provide an initial pressure drop of not more than 4 psig for water applications. For low pressure steam application, the pressure drop shall be equal to the supply pressure minus the heating element design inlet pressure.
  - c. Normal position of both heating and cooling valves shall be open. Three Way valves shall be piped to fail open to both heating and cooling.
  - d. Electric Bi-Directional actuators are acceptable on VAV Terminal Units and Reheat coil valve control if so noted.
  - e. All electric actuators for applications other than VAV terminal units and Reheat Coil valve Control shall be Proportional analog 4-20Ma or 0-10Vdc input and shall be positioned to reflect the output value of the computer control system and shall be spring return to normal position.
  - f. Belimo or equal
7. Dampers
- a. Automatic dampers, furnished by the Building Automation Contractor shall be single or multiple blade as required. Dampers shall be installed by the HVAC Contractor under the supervision of the BAS Contractor. All blank-off plates and conversions necessary to install smaller than duct size dampers are the responsibility of the Sheet Metal Contractor.
  - b. Damper frames shall be hat shaped channel, 4" deep constructed of 16 gauge galvanized steel. Stainless steel side seals, and sintered bronze, oil-impregnated bearings shall also be provided.
  - c. Damper blades shall be 16 gauge galvanized steel and shall be 6" on center. Provide vinyl-grip seals on blades.
  - d. Provide damper linkage that consists of 0.50" diameter steel, cadmium plated and chromate treated pivots. Provide a ¼-20 set-screw with a locking-patch to lock the pivots to a 0.31 diameter aluminum rod. Pivots shall rotate in a Celcon bearing. Blade brackets shall be 12 gauge cadmium plated steel. Blades shall be individually factory adjusted for maximum shut off.
  - e. Provide axles that are steel, 0.350" diameter cadmium plated and driveshafts that are ½" diameter cadmium plated steel, extendable 6".
  - f. For high performance applications, control dampers shall meet or exceed the UL Class I leakage rating.
  - g. Control dampers shall be Ruskin, Arrow or approved equal.
  - h. Unless otherwise noted, provide opposed blade dampers for modulating applications and parallel blade for two-position control.

### **PART 3 - EXECUTION**

#### **3.01 CONTRACTOR RESPONSIBILITIES**

- A. Demolition: Remove controls which do not remain as part of the building automation system, including all associated abandoned wiring, conduit, and pneumatic tubing within visible area of the new controls, up-to 10 feet away. The Owner will inform the Contractor of any equipment that is to be removed that will remain the property of the Owner. This equipment shall be handled with care so as not to damage it. All other equipment that is removed shall be disposed of by the Contractor.
- B. Cleanup: At the completion of the work, all equipment pertinent to this section shall be checked and thoroughly cleaned, and all other areas shall be cleaned around equipment provided under this section. Clean the exposed surfaces of tubing, hangers, and other exposed metal of grease, plaster, or other foreign materials.

C. Wiring, Conduit and Cable

1. ALL wiring (high voltage, 50 volts and greater) and conduit is to be installed in accordance with local and national electrical codes and Division 26 (Electrical Division) specification. Power circuitry shall originate from the nearest available 120V panel.
  - a. All temperature control cable less than 50 volts is to be considered low voltage.
  - b. All low voltage cable is to be run in conduit in any non-accessible concealed space and up to 10 ft. above floor level within mechanical rooms. Wiring above 10 ft or within accessible areas (ceilings, crawl spaces, between furred walls, enclosed chases) may be run exposed with proper support with bridle rings. Wiring is to be run parallel and perpendicular to building lines in a neat and workmanlike manner and bundled with nylon tie wraps.
  - c. Sensors and wiring on or in concrete or block walls for low voltage cable shall be surface mounted and enclosed in metallic wire-mold.
  - d. All low voltage cable shall be run separate from high voltage cable. All microprocessor communications cable shall be run separate from any low or high voltage cable.
  - e. Any cable running in plenum rated areas shall be plenum rated cable.
  - f. Wires and tubing shall be installed a minimum of three (3) inches from hot water, steam, or condensate piping.
  - g. A true earth ground shall be available in the building. Ground shall be run from the source electrical panel ground to each temperature control panel or controller.
  - h. Metallic surface raceway may be used in finished areas on non accessible masonry walls. All surface raceway in finished areas shall be color matched to the existing finish within the limitations of standard manufacturers' colors.

D. HARDWARE INSTALLATION

1. Installation Practices for Field Devices
  - a. Actuators shall be firmly mounted to give positive movement, and linkage shall be adjusted to give smooth continuous movement throughout 100 percent of the actuator stroke.
  - b. Actuators shall be stroked ~5%, tightened and returned to normal position to give a positive seal.
  - c. Relay outputs shall include transient suppression across all coils. Suppression devices shall limit transients to 150% of the rated coil voltage.
  - d. Water line mounted sensors shall be removable without shutting down the system in which they are installed.
  - e. For duct static pressure sensors, the high pressure port shall be connected to a metal static pressure probe inserted into the duct pointing upstream. The low pressure port shall be left open to the plenum area at the point that the high pressure port is tapped into the ductwork.
  - f. For building static pressure sensors, the high pressure port shall be inserted into the space via a metal tube. The low pressure port shall be piped to the outside of the building.
2. Enclosures:
  - a. For all I/O requiring field interface devices, these devices where practical shall be mounted in a field interface panel (FIP). The Contractor shall provide an enclosure that protects the device(s) from dust and moisture, and conceals integral wiring and moving parts.
  - b. FIPs shall contain power supplies for sensors, interface relays and contactors, safety circuits, and I/P transducers.
  - c. The FIP enclosure shall be of steel construction with baked enamel finish, NEMA 1 rated with a hinged door and keyed lock. All locks shall be keyed identically.

d. All outside mounted enclosures shall meet the NEMA-4 rating.

E. SOFTWARE INSTALLATION

1. General: The Contractor shall provide all labor necessary to install, initialize, start-up and debug all system software as described in this section. This includes any operating system software or other third party software necessary for successful operation of the system.
2. Database Configuration: The Contractor shall provide all labor to configure those portions of the database that are required by the point list and sequence of operation.
3. Color Graphic Slides: Unless otherwise directed by the owner, the Contractor shall provide color graphic displays as depicted in the schematic drawings for each system and floor plan. For each system or floor plan, the display shall contain the associated points identified in the point list and allow for setpoint changes as required by the owner.

F. COMMISSIONING AND SYSTEM STARTUP

1. Point to Point Checkout: Each I/O device (both field mounted and those located in FIPs) shall be inspected and verified for proper installation and functionality. A checkout sheet itemizing each device shall be filled out, dated and approved by the Project Manager for submission to the owner or owner's representative.
2. Controller and Workstation Checkout: A field checkout of all controllers and front-end equipment (computers, printers, modems, etc.) shall be conducted to verify proper operation of both hardware and software. A checkout sheet itemizing each device and a description of the associated tests shall be prepared and submitted to the owner or owner's representative by the completion of the project.
3. System Acceptance Testing:
  - a. All application software shall be verified and compared against the sequences of operation. Control loops shall be exercised by inducing a setpoint shift of at least 10% and observing whether the system successfully returns the process variable to setpoint. Record all test results and attach to the Test Results Sheet.
  - b. Test each alarm in the system and validate that the system generates the appropriate alarm message, that the message appears at all prescribed destinations (workstations or printers), and that any other related actions occur as defined (i.e. graphic panels are invoked, reports are generated, etc.). Submit a Test Results Sheet to the owner.
  - c. Perform an operational test of each unique graphic display and report to verify that the item exists, that the appearance and content are correct, and that any special features work as intended. Submit a Test Results Sheet to the owner.
  - d. Perform an operational test of each third party interface that has been included as part of the automation system. Verify that all points are properly polled, that alarms have been configured, and that any associated graphics and reports have been completed. If the interface involves a file transfer over Ethernet, test any logic that controls the transmission of the file, and verify the content of the specified information.

**END OF SECTION**