SECTION 15900

HVAC Controls

PART 1 GENERAL

1.1 SUMMARY

A. This section describes requirements for HVAC Controls.

1.2 DESCRIPTION

A. Existing System:

1. The existing Building Automation System (BAS) is based on open and interoperable LonWorks. Control network communications (LonTalk) meets the requirements of ANSI/EIA 709.1.

2. Multiple LonWorks Local Area Networks are interconnected on the ANC LAN/WAN using Ethernet connections. The standardized protocols used for all communications are LonTalk and TCP/IP over Ethernet.

3. Network services for the BAS is provided through LonWorks Network Services (LNS).

4. A Supervisory system connected to the ANC LAN monitors all the HVAC controls, and provides a graphical interface. In addition, Web Server Host Systems provides browser-based access to monitor system information and change systems setpoint from anywhere in the controls network, anywhere on the Airport LAN/WAN, or from the Internet.

5. The Bindings Database for the system is maintained by ANC on operator's work stations connected to the BAS over the LAN.

6. The LonWorks LANs are provided with sufficient numbers of routers to serve all the HVAC controls zones shown on the Concourse C - Phase 2 - Building Completion drawings, AKSAS 54475, including those zone indicated as "Future."

7. The supervisory system supports MODBUS protocol, which provides routers to connections to the boiler and chiller controls via the Airport's LAN/WAN.

B. Tenant Requirements:

1. Provide HVAC controls for all controllers installed by the Tenant in accordance as described in the Section.

2. The scope of control work under tenant improvement includes extending local LonWorks LANs. Where the number of devices added by a Tenant exceed the numbers required for the building HVAC control indicated in the Building Completion Drawings additional LonWorks routers may be necessary. These LonWorks routers shall be provided at the Tenant's expense. Requirements for additional interfaces to the ANC LAN are not anticipated, and are not included as a Tenant requirement. Establishing graphical interfaces, setpoints, or alarm reporting to the supervisory system is not included.

3. Interface with existing LonWorks controls. Obtain a copy of the current Master Control drawings for use in designing tenant controls. Obtain approval of the tenant system design from ANC prior to installation.

4. Program new controllers off-line using a tool compatible with the ANC binding database. Obtain approval of system programming from ANC prior to binding the new controllers. Coordinate with ANC to import the new program pages into the binding database, and to bind the controllers.

5. Comply with the requirements described in SUBMITTALS.

6. Hardware Requirements:

   a. Provide LonMark compliant control products that communicate on LonMark LANs or the Ethernet.

   b. Provide LonTalk routers as required to add LonMark LANs if there are insufficient capacity on existing routers.

   c. Provide Application Specific Controllers (ASC), Application Generic Controllers (AGC), and Custom Application Controllers (CAC) as herein specified.

   d. Provide wire, raceway systems, backboxes, 24 DC and/or 24 AC power supplies and final connections to nodes provided by this Division and the following ASCs, AGCs and CACs as provided by other Divisions.

      1) Intelligent Air Terminal Device Controllers (i.e., VAV, Dual Duct, FPB, etc.).

      2) Intelligent Damper Operators.

      3) Intelligent Valve Operators.

      4) Packaged Air Handling Units.

      5) Other HVAC Equipment.

   e. Provide ANC with product literature, External Interface Files (XIF) (floppy, CD-ROM, or Zip disk format), and Object Diagrams for all products.

7. Software Requirements:

   a. All LonWorks devices shall utilize the existing LNS.

   b. Utilize programming and binding tools compatible with the existing binding database.

   c. Provide all programming of devices furnished under the tenant improvement project.

   d. Coordinate with ANC to integrate the database developed by the Tenant into the ANC master database

   e. Coordinate with ANC to bind the Tenant controls into the ANC network.

8. Furnish the services of a Commissioning Agent that is independent of the controls installer to provide commissioning services. Comply with commissioning requirements described in Section 15945 Controls Testing and Acceptance. Provide all equipment necessary to generate trend data required by Section 15945.

9. Comply with specific requirements for sequences of operation described in Section 15940 Sequences of Operation.

C. ANC Responsibilities:

1. Furnish copies of existing control system record documents for use in design of the Tenant's controls.

2. Assistance in clarification of the existing control system design.

3. Review of the Tenant's control design for compatibility with the existing controls, and compliance with the ANC requirements.

4. Integrate the LNS database developed by the Tenant into the master database.

5. Bind the Tenant controls into the Airport control network.

6. Integrate the Tenant controls into the supervisory system, including graphics, alarm reporting.

7. Integrate the Tenant control O&M manuals into the master O&M manuals.

1.3 SUBMITTALS

A. Submit and obtain approval from ANC of system design prior to installation HVAC controls. Include all drawings, calculations, proposed bindings, graphical programming, and product literature.

B. Provide ANC with O&M Manuals of the completed tenant system. Include:

1. All control shop drawings, calculations, proposed bindings, and graphical programming

2. Product Data listed in PRODUCT DATA.

1.4 QUALITY ASSURANCE

A. HVAC Control Installer shall furnish and install LonWorks products manufactured by multiple manufacturers as required.

B. All microprocessor based control products (excluding workstations) used shall include a Neuron chip or other processor with complete implementation of the LonTalk protocol stack.

C. Comply with LonMark Interoperability Association, Interoperability Guidelines for all products. Utilize published functional profiles for all product network message and configuration parameters. Where published profiles do not exist, utilize draft profile standards or submit a proposed draft as part of the submittals required in Section 6. All drafts shall also be submitted simultaneously to the LonMark Interoperability Association and a copy of such transmittal submitted to the Architect

D. Individual products shall conform whenever possible to the LONMARK Interoperability Standards. If products are not certified by the LONMARK organization, product submittals must include the application source code, external interface file, resource files and complete documentation regarding all network variables and configuration properties supported by the device.

E. Control devices connected to the LonWorks control network shall be readily replaceable with devices from other manufacturers.

1.5 PRODUCT DATA

A. For each microprocessor based device on the control network (or proposed for the system), submit the documentation detailed below. ANY control device that is furnished without External Interface Files (XIF) or object diagrams shall be submitted under separate cover with indication of non-compliance to specification.

1. Product literature, External Interface Files (XIF) (floppy, CD-ROM, or Zip disk format), and Object Diagrams.

2. Listing and explanation of both standard and user defined configuration parameters for the device.

3. Product documentation shall display the LonMark symbol indicating conformance to the LonMark Interoperability Standards. Submit the LonMark profile identification and manufacturer's part number for each controller.

4. Each Custom Application Controller (CAC) should additionally be submitted with the following information. These items shall be grouped together under product model for easy reference.

    a. Preliminary logical control diagram indicating the Network Variables in and out of control unit with message bindings visually indicated.

    b. Descriptive sequence of operation.

    c. Programming tool used to produce application.

    d. Application tool source code.

    e. Preliminary programming source code or graphic.

    f. Wiring interconnection diagrams for power, communication and external I/O.

B. Provide detailed cutsheets to ANC indicating the features, accessories and sub-assemblies of the following:

1. Computer equipment, all operating systems, application software, programming tools, network devices.

2. Printers and other peripherals.

3. Ethernet LAN Switches (shared media hubs not acceptable).

4. Repeaters, media converters, bridges and routers.

5. LonWorks Network Services plug-ins.

1.6 SHOP DRAWINGS

A. Submit a marked-up copy of the ANC master control drawings showing exact point of interface to the controls installed by the tenant. Make specific references to the pertinent tenant control drawings on the ANC Master.

B. Submit control drawings for the tenant controls. Requirements include:

1. Specific reference to the ANC master controls at the exact points of interface.

2. Plans: Provide AutoCAD 2000 or later generated floor plans indicating exact installed location of the following equipment and/or devices:

    a. Application Generic controllers.

    b. Application Specific controllers.

    c. Customer Application Controllers.

    d. Sensors located in Finished Areas.

    e. I/O installed in mechanical systems (ductwork, pipes, AHUs, etc.).

    f. Routers, Gateways and Bridges.

    g. Lon Control Units installed by Division M and E trade contractors.

    h. Other BAS related components, sensors and actuators.

i. Scale of floor plan drawings shall be no less than 1/8 inch per foot, and shall be presented with a suitable title block identifying the project, contractor, title of the drawing, date, author, revisions, area of the building with a key plan, and a graphical scale. Drawings may be plotted at half size provided all elements are clearly legible.

3. System Diagrams: Include the following:

a. Logical and physical diagrams for each channel indicating each node, node address (domain, subnet and group) channel type and router specifications. Submit network performance calculations for each channel.

b. Electrical low voltage power wiring schematic indicating voltage drop calculations, wire size, node power consumption, maximum full load circuit amperage.

c. Submit functional temperature control diagrams for each mechanical system served by the BAS. Indicate and Tag each input/output served by each Control Unit or Intelligent Device.

d. Local Area Network and LonWorks Architecture diagram indicating supervisory controllers. Include explicit information regarding configuration of Routers, Bridges and Repeaters installed by the Tenant. Submit performance calculations for all channels to indicate bandwidth utilization and conformance to the requirements outlined in Section 1.1, “LonWorks Network Management”.

e. Interface requirements with other systems including but not limited to: security systems, lighting control, fire alarm, elevator status, power monitoring system. Diagrams detailing the variables mapped between protocols shall be submitted for all gateways.

PART 2 PRODUCTS

2.1 APPLICATION SPECIFIC CONTROLLER (ASC)

A. General Requirements:

1. Application Specific Controllers shall be equipped with *either a 3120 or a 3150 Neuron* microprocessor controller, a minimum of 64K programmable non-volatile (flash) memory for general data processing, power supply, input/output modules, termination blocks, network transceivers.

2. Operating system software, custom operating sequence software and application programs shall be stored in programmable, non-volatile memory.

3. The ASC unit may be equipped with a dedicated software clock battery. If included, the battery shall be capable of maintaining time of day, day of week, date, month, and year, independent of system power for a two-week period. Include an integral calendar with automatic leap year compensation.

4. ASC packaging shall be such that complete installation and checkout of field wiring can be performed prior to the installation of electronic boards. Make all board terminations by means of plug-in connectors to facilitate troubleshooting, repair and replacement.

B. ASC Interface Software

1. General: ASC shall be configured, not programmed, via PC based interface software. This software shall be a program applet that runs within the network management tool chosen. Intimate knowledge of operation of ASC shall not be required for configuration.

2. ASC shall provide a selection of control applications performable through configuration of the device. Download of new application should not be required for one of these applications.

C. ASC Device Software:

1. General: An ASC shall operate in standalone mode as needed for specified control applications if network communication fails. Software shall include a complete operating system (O.S.), communications handler, point processing, standard control algorithms, and specific control sequences.

2. O.S. software shall reside in programmable flash memory, operate in real-time, provide prioritized task scheduling, control time programs, monitor and manage network communications, and scan inputs and outputs. O.S. shall also contain built in diagnostics.

2.2 APPLICATION GENERIC CONTROLLER (AGC)

A. General Requirements:

1. Application Generic Controllers shall be equipped with *either a 3120 or a 3150 Neuron microprocessor controller,* a minimum of 64K programmable non-volatile (flash) memory for general data processing, power supply, input/output modules, termination blocks, network transceivers.

2. Operating system software, custom operating sequence software and application programs shall be stored in programmable, non-volatile memory.

3. The AGC unit may be equipped with a dedicated software clock battery. If included, the battery shall be capable of maintaining time of day, day of week, date, month, and year, independent of system power for a two-week period. Include an integral calendar with automatic leap year compensation.

4. AGC packaging shall be such that complete installation and checkout of field wiring can be performed prior to the installation of electronic boards. Make all board terminations by means of plug-in connectors to facilitate troubleshooting, repair and replacement. Network and power wiring shall allow for 'pass-thru' of signal when electronic boards are removed.

B. AGC Interface Software

1. General: AGC shall be configured, not programmed, via PC based interface software. This software shall be a program applet that runs within the network management tool chosen. Intimate knowledge of operation of AGC shall not be required for configuration.

2. AGC shall provide a selection of control function blocks that can be configured. Download of new applications from network management tool shall be possible, but not required.

2.3 CUSTOM APPLICATION CONTROLLER (CAC)

A. General Requirements:

1. Custom Application Controllers shall be equipped with either a 3120 or a 3150 Neuron microprocessor controller, a minimum of 64K programmable non-volatile (flash) memory for general data processing, power supply, input/output modules, termination blocks, network transceivers.

2. Operating system software, custom operating sequence software and application programs shall be stored in programmable, non-volatile memory.

3. The CAC unit may be equipped with a dedicated software clock battery. If included, the battery shall be capable of maintaining time of day, day of week, date, month, and year, independent of system power for a two-week period. Include an integral calendar with automatic leap year compensation.

4. CAC packaging shall be such that complete installation and checkout of field wiring can be performed prior to the installation of electronic boards. Make all board terminations by means of plug-in connectors to facilitate troubleshooting, repair and replacement. The complete CAC including accessory devices such as relay, transducers, power supplies, etc. shall be factory-mounted, wired and housed in a NEMA 1 enclosure or as required by the location and local code requirements.

5. Equip CAC's with diagnostic indicators for the following:

   a. Transmit.

   b. Receive.

   c. Power up test.

   d. Power up fail.

   e. Power up test okay.

   f. Bus error.

B. CAC Software:

1. General: A CAC shall operate in standalone mode as needed for specified control applications if network communication fails. Software shall include a complete operating system (O.S.), communications handler, point processing, standard control algorithms, and specific control sequences.

2. O.S. software shall reside in programmable flash memory, operate in real-time, provide prioritized task scheduling, control time programs, monitor and manage CAC to OI communications, and scan inputs and outputs. O.S. shall also contain built in diagnostics.

3. Input/Output Point Processing Software shall include:

   a. Continuous update of input and output values and conditions. All connected points are to be updated at a minimum of one-second intervals.

   b. Analog to digital conversion, scaling and offset, correction of sensor non-linearity, sensing no response or failed sensors, and conversion of values to 32 bit floating point format. Both the maximum and minimum values sensed for each analog input are to be retained in memory. It shall be possible to input subsets of standard sensor ranges to the A/D converter and assign gains to match the full-scale 32-bit conversion to achieve high accuracy readout.

   c. A reasonability check on all analog inputs against the previously read value and discard those values falling outside pre-programmed reasonability limits.

   d. Assignment of proper engineering units and status condition identifiers to all analog and digital input and outputs.

   e. Analog input alarm comparison with the ability to assign two individual sets of high and low limits (warning and actual alarm) to an input or to assign a set of floating limits (alarm follows a reset schedule or control point) to the input. Each alarm shall be assigned a unique differential to prevent a point from oscillating into and out of alarm. Alarm comparisons shall be made each scan cycle.

f. Debounce of digital inputs to prevent nuisance alarms. Debounce timing shall be adjustable from two seconds to two minutes in one second increments.

4. Alarm Lockouts:

   a. Alarm lockout software shall be provided to prevent nuisance alarms. on initial start-up of air handler and other mechanical equipment a "timed lockout" period shall be assigned to analog points to allow them to reach a stable condition before activating alarm comparison logic. Lockout period is to be programmable on a per point basis from 0 to 90 minutes in one minute increments.

   b. A "hard lockout" shall also be provided to positively lock out alarms when equipment is turned off or when true alarm is dependent on the condition of an associated point. Hard lockout points and lockout initiators are to be operator programmable.

   c. Design the power supply to accommodate the power requirements of all components (or nodes) connected, plus 50 percent.

5. Run Time Totalization or Point Trending:

   a. Run time shall be accumulated based on the status of a digital input point. It shall be possible to totalize either on time or off time up to 10,000 hours with one-minute resolution. Run time counts shall be resident in non-volatile memory and have CAC resident run time limits assignable through the operator's terminal.

   b. Totalized run time or trended data shall be batch downloaded using FTP to the SS on a daily or weekly basis. Trended data shall reside on the SS database server. The automatic update of this data shall be determined by the SS and facility management application requirements.

6. Transition Counting: A transition counter shall be provided to accumulate the number of times a device has been cycled on or off. Counter is to be non-volatile and be capable of accumulating 600,000 switching cycles. Limits shall be assignable to counts to provide maintenance alarm printouts.

7. Custom Direct Digital Control (DDC) Loops:

   a. Custom DDC programs are to be provided to meet the control strategies as called for in the sequence of operation sections of these specifications. Each CAC shall have residential in its memory and available to the programs a full library of DDC algorithms, intrinsic control operators, arithmetic, logic and relational operators for implementation of control sequences:

      1) Proportional Control, Proportional plus Integral (PI), Proportional plus Integral plus Derivative (PID), and Adaptive Control (self-learning): The adaptive control algorithm shall be used on control loops, as indicated in I/O summary, where the controlled medium flow rate is variable (such as VAV units and variable flow pumping loops). The adaptive control algorithm shall monitor the loop response characteristics in accordance with the time constant changes imposed by variable flow rates. The algorithm shall operate in a continuous self-learning manner and shall retain in memory a stored record of the system dynamics so that on system shutdown and restart, the learning process starts from where it left off and not from ground zero. Standard PID algorithms are not acceptable substitutes for variable flow applications since they will provide satisfactory control at only one flow rate and will require continued manual fine tuning.

      2) All DDC setpoints, gains and time constants associated with DDC programs shall be available to the operator for display and modification via the SS operator interface, two (2) portable operator's terminal and two (2) SS workstation.

3) The execution interval of each DDC loop shall be adjustable from 2 to 120 seconds in one-second increments.

4) DDC control programs shall include an assignment of initialization values to all outputs to assure that controlled devices assume a fail-safe position on initial system start-up.

2.4 VAV CONTROLLERS

A. Provide terminal units controllers with microprocessor based Interoperable LonMark controller bearing the LonMark interoperability logo on each product delivered. The controller networking communication protocol shall be based on the Echelon Neuron 3150 microprocessor physically located in the controller.

B. Provide manufacturers thermostat matched to controller. Refer to Section 15910 for requirements.

2.5 *LONWORKS* ROUTERS, BRIDGES, REPEATERS AND TRANSCEIVERS

A. Routers, Bridges and Repeaters.

1. Equip each router and bridge with a network transceiver on each network port (inbound and outbound) as dictated by the network type (Type 1 - FTT, Type 2 - TP, Type 3 - PL, Type 4 - LP, Type 5 - RF).

2. The network router shall be designed to route messages from a segment, sub-net, or domain in full duplex communication mode.

3. Routers and bridges shall utilize LonTalk protocol transport, network, session layers to transparently route messages bound for a node address in another sub-net or domain. Routers with TCP/IP capability shall be provided where TCP/IP backbone is used. In this case, Lontalk IP encapsulation shall be utilized in accordance with Lonmark guidelines.

4. Routers, bridges and repeaters shall be fully programmable and permit a systems integrator to define message traffic, destination, and other network management functions utilizing LonWorks technology, NetMaker and Net Profiler installation tools through the LonManager Software package or other LonManager API based Network Management tool.

5. The routers, bridges, and repeaters shall be capable of DIN rail or panel mounting and be equipped with status LED lights for Network traffic and power.

6. Provide a minimum of (2) Neuron 3150 processors for use as the network router communication controller.

B. Transceivers:

1. Type 1 Network Transceiver, Free Topology, Twisted Pair: Provide a transformer isolated, twisted pair transceiver capable of mounting directly on a printed circuit board. The transceiver shall meet the following specifications:

a. Meets LONMARK Interoperability Association Standards.

b. Differential Manchester encoded signaling for polarity insensitive network wiring.

c. Transformer isolated for common mode rejection.

d. 78 K/ps network bit rate up to distances of 2000m.

e. Free topology supports star, home run, multi drop and loop wiring topologies.

f. Complies with FCC and VDE requirements.

g. UL recognized component.

2. Type 2 Network Transceiver, Twisted Pair: Provide a transformer isolated twisted pair transceiver capable of mounting directly on a printed circuit board. The transceiver shall meet the following specifications:

a. Meets LONMARK interoperability standards.

b. Differential Manchester encoded signaling for polarity insensitive network wiring.

c. Transformer isolation for common mode rejection.

d. 1.25 Mb/s network bit rate up to distances of 1000 meters.

e. Unpotted construction.

f. Less than 1 mA power consumption with +5VDC input voltage.

g. FCC and VDE Level B requirements compliance.

h. UL Listed.

3. Type 3 Network Transceiver, Power Line:

a. Provide a direct sequence, spread spectrum power line transceiver which is equipped with the following signal processing and error correction capabilities to provide robust and error free communications.

1) Forward Error Correction (FEC) to enable the system to read and reconstruct corrupted packets without sacrificing throughput. The FEC shall require only six percent overhead for error correction.

2) Automatic sensitivity adjustment algorithm that dynamically changes the receiver sensitivity based on noise characteristics.

3) Oversampling correlation filter and adaptive data recovery algorithm to synchronize instantaneously to incoming packets.

4) Tri-state power amplifier/filter combination to provide a powerful output signal with a minimum number of components.

b. The transceiver shall be able to operate using the controller power supply and coupling circuit. Provide the following general features as a minimum:

1) Packaged in a rugged, potted module.

2) Programmable clock output (1.25, 2.5, 5 or 10 Mhz).

3) 10 Kb/s network transmission rate.

4) Packet detect output to drive a status indicator LED.

5) Minus 20 to plus 85 degrees C. operating temperature range.

6) UL Listed.

4. Type 4 Network Transceiver, Link Power: Provide a twisted pair transceiver that utilizes the twisted pair communication media to provide power for the LonWorks Controller(s). The transceiver shall meet the following specifications:

a. Free single-in-line package (SIP) construction.

b. Send both network data and power on a twisted wire pair.

c. Meets LONWORKS interoperability standard.

d. Differential Manchester encoded signaling for polarity insensitive network wiring.

e. 78 Kb/s network bit rate up to distances of 320 meters.

f. Supports star, home run, multidrop, and loop wiring.

g. Supplies +5VDC @ 100 mA maximum for node power.

h. Compliance with FCC and VDE requirements.

i. UL Listed.

5. Type 5 Network Transceiver, Radio Frequency: Provide a direct sequence, spread spectrum RF transceiver that meets the following specifications:

a. 100 meter open field range.

b. Wireless communications extends network between buildings and to vehicles and portable devices.

c. FCC type certifiable, 48 MHz.

d. Low-cost miniature circuit board, SMT components.

e. Carrier detect output to drive a status indicator LED.

f. Plus 7 to plus 15VDC input voltage.

g. Minus 20 to plus 60 degrees C. operating temperature range.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Locate all controllers, relays, switches, for equipment within equipment rooms in enclosed control panels with hinged locking doors. For equipment located in exposed areas subject to outside weather conditions, mount all control devices inside weatherproof enclosures. To optimize the design of the system the exact number and location of controller panels must not interfere with operation of any access to other equipment.

B. Mount control panels adjacent to associated equipment on vibration-free walls or freestanding angle channel supports. One cabinet may accommodate more than one system in same equipment room. Provide engraved plastic nameplates for instruments and controls inside cabinet and engraved laminated nameplates on cabinet face.

C. Field equipment outboard of the controller panel shall be installed in field panels. All field mounted devices, equipment, control circuits and contacts and transducers shall be located in field panels. Exception: Point of measurement sensors; i.e. temperature or pressure sensors.

D. Field panels shall be general purpose NEMA 1. Panels located out of doors or installed in high moisture areas shall be NEMA 3R. Panels mounted exterior to the building shall be NEMA 3R and constructed of 16 gage steel (minimum) with a front-hinged door with lock and keyed to building keying system.

E. Application Specific Controllers (ASCs): Terminal unit shall be installed and calibrated for terminal unit operation and control sequences. Settings shall be stored in non-volatile memory. Unit shall come tagged from the factory with identification of all setpoints (minimum and maximum air capacity, heating/cooling setpoints, control sequence, etc.).

F. When a hand-off-auto (H-O-A) switch has been provided, control the equipment while the equipment is in the auto mode only, except that safety shutdown features shall remain operational in all modes of operation.

G. Safeties: All equipment safeties shall be hardwired within the motor control circuit or motor starter. Operational safeties include, but are not limited to: freeze protection thermostats and duct work over pressurization pressure switches. Life safety safeties include, but are not limited to duct smoke detectors. Auxiliary contacts shall be provided to allow supervision by the building automation system.

H. Provide all required ventilation, cooling, structural support, electrical power, power conditioning and surge protection (with reset) as required to ensure system performance and reliable equipment operation.

I. Sensors shall have accuracy as stated in Section 15910. Accuracy shall include total sensor to read-out accuracy. Instrument characteristics such as hysteresis, relaxation of time, span and maximum and minimum limits shall be accounted for in applications of sensors and controls.

J. Use approved designations for all room names, spaces, equipment tags, etc.

3.2 ELECTRICAL RACEWAYS

A. All wiring shall run in conduit, except runouts to terminal unit controllers located above the ceiling may be exposed.

B. Control wiring and AC power wiring shall not share the same conduit nor shall they occupy the same enclosure unless an appropriate grounded metallic barrier is installed between these wiring types.

C. Pneumatic tubing shall not share the same conduit or raceway with control or AC power wiring.

D. Wiring methods shall be in accordance with the requirements of applicable codes and criteria as indicated in Division 16 of these Tenant Requirements.

E. Wiring from remote equipment shall be to terminal blocks. The terminal blocks shall be permanently marked for identification. Protect all circuits to avoid interruption of service due to short-circuiting or other conditions that might adversely affect the connected devices. Number the blocks by circuit pairs, such as one to 25, 26 to 50, etc. Classify each individual signaling circuit as a circuit pair.

F. Label or code each field wire at each end using Ray-Chem or approved equal heat shrink markers. Permanently label or code each point of all field terminal strips to show the instrument or item served. Color coded cable with cable diagrams may be used to accomplish cable identification.

G. Splices shall not be made in shielded wiring except where specifically approved. Splices shall be made on terminal blocks in approved junction boxes. Outlet boxes shall not be used for splices. Comply with labeling requirements noted above.

H. Provide power to the equipment from a source(s) compatible with the load and acceptable to the Contracting Agency.

I. Standby Generator power shall be used to power equipment used for alarms, and for equipment controlling or monitoring systems on emergency/standby power.

J. Plug or cap all unused conduit openings and stub-ups. Do not use caulking compound.

K. Size conduit for a maximum of 40 percent fill.

L. Plenum cable may be used for runouts to terminal unit controllers. Plenum cable shall be UL Listed cable for use in air handling plenums (i.e., Teflon™ coated or mineral insulated wire).

M. Coverplates: Provide blank finished coverplates where required on junction or pullboxes. Finish shall be consistent with existing room decor and approved by the Architect.

N. Conceal raceways above the ceilings and in the walls of occupied spaces.

O. Support raceways and wiring systems from the structure, not from mechanical equipment, mechanical ductwork, suspended ceilings or other building elements.

P. Conceal conduit within finished shafts, ceilings and wall as required. Install exposed conduit parallel with or at right angles to the building walls.

Q. Conduits located in areas where the ceiling is exposed to the structure shall be painted to match the finish of the ceiling.

R. Mark the covers of all junction boxes with "BAS" using a permanent label.

S. Provide supervised field-wiring for all alarm panel monitoring points, asset protection points (safeties, sump pumps, maintenance alarms) and all points identified to include supervised wiring on the points schedule.

T. Where conduit is attached to vibrating or rotating equipment, flexible metal conduit with a minimum length of 18 inches and maximum length of 36 inches shall be installed and anchored in such a manner that vibration and equipment noise will not be transmitted to the rigid conduit.

U. Where exposed to the elements or in damp or wet locations, waterproof flexible conduit shall be installed. Installation shall be as specified for flexible metal conduit.

3.3 IDENTIFICATION

A. Refer to Section 15075 - Mechanical Identification.

B. All panels shall have nameplates.

C. Identify all equipment and panels. Identification shall be with tags describing equipment and panel use and function. Include point names, physical address, and space number of the area served on field sensors and actuators.

D. Valve actuator, control device and monitoring equipment identification shall be by tags that are chain attached or securely fastened to the equipment or device.

E. Apply the numbering system used in the existing controls to new lines and terminals within a panel with line number matching terminals shown on control diagrams. All wires and cables shall be identified with permanent markers at each end.

END OF SECTION