PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

B. Although Specifications throughout the Mechanical, Electrical, Communications, Electronic Safety and Security divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them; additional Divisions also may be reciprocally applicable to this Section.

1.02 SUMMARY

A. Section includes:
   2. Advance Application Specific Controller (AAC).
   3. Application Specific Controller (ASC).

B. Furnish and install DDC Control units and/or Smart Devices required to support specified building automation system functions.

C. Refer to Section 25 00 10 for general requirements.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within all references.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.
2.02 STAND-ALONE FUNCTIONALITY

A. General: These requirements clarify the requirement for stand-alone functionality relative to packaging I/O devices with a controller. Stand-alone functionality is specified with the controller and for each Application Category specified in this Section. This item refers to acceptable paradigms for associating the points with the processor.

B. Functional Boundary:
   1. Provide controllers so that all points associated with and common to one unit or other complete system/equipment shall reside within a single control unit. The boundaries of a standalone system shall be as dictated in the Contract Documents.
   2. Systems specified for the Application Category will dictate the boundary of the standalone control functionality. See related restrictions below.
   3. When referring to the controller as it pertains to the standalone functionality, reference is specifically made to the processor.
   4. One processor shall execute all the related I/O control logic via one operating system that uses a common programming and configuration tool.

C. The following configurations are considered acceptable with reference to a controller’s standalone functionality:
   1. Points packaged as integral to the controller such that the point configuration is listed as an essential piece of information for ordering the controller (having a unique ordering number).
   2. Controllers with processors and modular back planes that allow plug in point modules as an integral part of the controller.
   3. I/O point expander boards, plugged directly into the main controller board to expand the point capacity of the controller.

D. The following configurations are considered unacceptable with reference to a controller’s standalone functionality:
   1. I/O point expansion devices connected to the main controller board via wiring and as such may be remote from the controller and that communicate via a sub LAN protocol.
   2. Multiple controllers enclosed in the same control panel to accomplish the point requirement.

2.03 BUILDING CONTROLLER (BC)

A. The BC(s) shall provide fully distributed control independent of the operational status of the OWSs and CSS. All necessary calculations required to achieve control shall be executed within the BC independent of any other device. All control strategies performed by the BC(s) shall be both operator definable and modifiable through the Operator Interfaces.
B. BCs shall perform overall system coordination, accept control programs, perform automated HVAC functions, control peripheral devices and perform all necessary mathematical and logical functions.

C. BCs shall share information with the entire network of BCs for full global control directly without requiring other BCs, LAN devices, Local Supervisory LAN gateways, routers etc. to assist, perform, or act as an intermediate device for communicating.

D. Each controller shall permit multi-user operation from multiple workstations and portable operator terminals connected either locally or over the Primary Controller LAN. Each unit shall have its own internal RAM, non-volatile memory, microprocessor, battery backup, regulated power supply, power conditioning equipment, ports for connection of operating interface devices, and control enclosure.

E. BCs shall be programmable from an operator workstation, portable operator terminal, or hand held operating device. BC shall contain sufficient memory for all specified global control strategies, user defined reports and trending, communication programs, and central alarming.

F. BCs shall be connected to a controller network that qualifies as a Primary Controlling LAN.

G. All BCs shall be protected from any memory loss due to a loss of power, power surge, or unstable power by one or a combination of the following:
   1. Volatile RAM shall have a battery backup using a lithium battery with a rated service life of fifty (50) hours, and a rated shelf life of at least five (5) years. Self-diagnostic routine shall report an alarm for a low battery condition.
   2. EEPROM, EPROM, or NOVROM non-volatile memory.

H. In addition, BCs shall provide intelligent, standalone control of HVAC functions. Each BC shall be capable of standalone direct digital operation utilizing its own processor, non-volatile memory, input/output, wiring terminal strips, A/D converters, real-time clock/calendar and voltage transient and lightning protection devices. Refer to standalone functionality specified above.

I. For systems requiring end-of-line resistors those resistors shall be located in the BC.

J. Input-Output Processing:
   1. Digital Outputs (DO):
      a. Outputs shall be rated for a minimum 24 Vac or Vdc, 1 amp maximum current. Each shall be configurable as normally open or normally closed.
      b. Each output shall have an LED to indicate the operating mode of the output and a manual hand off or auto switch to allow for override. Provide feedback to remotely indicate the HOA is not in the Auto position. If these HOA switches are not provided on the main board they shall be provided via isolation relays within the control enclosure.
      c. Each DO shall be discrete outputs from the BC’s board (multiplexing to a separate manufacturer’s board is unacceptable). Provide suppression to limit transients to acceptable levels.
   2. Analog Inputs (AI):
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Insert Project Name

a. AI shall be 0-5 Vdc, 0-10 Vdc, 0-20 Vdc, and 0-20 mA. Provide signal conditioning, and zero and span calibration for each input.

b. Each input shall be a discrete input to the BC’s board (multiplexing to a separate manufacturers board is unacceptable unless specifically indicated otherwise).

c. A/D converters shall have a minimum resolution of twelve (12) bits.

3. Digital Inputs (DI):

a. Monitor dry contact closures.

b. Accept pulsed inputs of at least one per second. Source voltage for sensing shall be supplied by the BC and shall be isolated from the main board.

4. Universal Inputs (UI-AI or DI): To serve as either AI or DI as specified above.

5. Electronic Analog Outputs (AO):

a. Voltage mode: 0-5 Vdc and 0-10 Vdc; Current mode: 4-20 mA. Provide zero and span calibration and circuit protection.

b. Pulse Width Modulated (PWM) analog via a DO and transducer is acceptable only with Owner approval (Generally these will not be allowed on loops with a short time constant such as discharge temperature loops, economizer loops, pressure control loops and the like. They are generally acceptable for standard room temperature control loops.).

c. Where these are allowed, transducer/actuator shall be programmable for normally open, normally closed, or hold last position and shall allow adjustable timing. Each DO shall be discrete outputs from the BC’s board (multiplexing to a separate manufacturers board is unacceptable).

d. D/A converters shall have a minimum resolution of ten (10) bits.

6. Analog Output Pneumatic (AOP), 0-20 psi:

a. Pneumatic outputs via an I/P transducer, or digital to pneumatic transducer are acceptable.

b. Multiplexed digital to pneumatic transducers are acceptable provided they are supplied as a standard product and part of the BC and provide individual feedback.

c. Multiplexed pneumatic outputs of a separate manufacturer are unacceptable.

7. Pulsed Inputs:

a. Capable of counting up to eight (8) pulses per second with buffer to accumulate pulse count.

b. Pulses shall be counted at all times.
K. BC Power Loss:
1. Upon a loss of power, power surge, or unstable power to any BC, the other units on the primary controlling network shall not in any way be affected.

2. Upon a loss of power, power surge, or unstable power to any BC, the battery backup shall ensure that the energy management control software, the Direct Digital Control software, the database parameters, and all other programs and data stored in the RAM are retained for a minimum of fifty (50) hours. An alarm diagnostic message shall indicate that the BC is under battery power.

3. Upon restoration of power within the specified battery backup period, the BC shall resume full operation without operator intervention. The BC shall automatically reset its clock such that proper operation of any time dependent function is possible without manual reset of the clock. All monitored functions shall be updated.

4. Should the duration of a loss of power exceed the specified battery back-up period or BC panel memory be lost for any reason, the panel shall automatically report the condition (upon resumption of power) and be capable of receiving a download via the network, and connected computer. In addition, the Owner shall be able to upload the most current versions of all energy management control programs, Direct Digital Control programs, database parameters, and all other data and programs in the memory of each BC to the operator workstation via the local area network, or via the telephone line dial-up modem where applicable, or to the laptop PC via the local RS-232C port.

L. BC Failure:
1. Building Controller LAN Data Transmission Failure: BC shall continue to operate in stand-alone mode. BC shall store loss of communication alarm along with the time of the event. All control functions shall continue with the global values programmable to either last value or a specified value. Peer BCs shall recognize the loss, report alarm and reconfigure the LAN.

2. BC Hardware Failure: BC shall cease operation and terminate communication with other devices. All outputs shall go to their specified fail position.

M. BCs may include LAN communications interface functions for controlling secondary controlling LANs Refer to Section 25 30 10 - BAS System Communications Devices for requirements if this function is packaged with the BC.

N. All BC naming conventions shall adhere to the format as established by the Owner’s Standard Acronyms document.

O. I/O Point Expansion Devices communicating to BC via a sub LAN protocol:
1. Utilizing any point from a point expansion device communicating to BC via a sub LAN protocol to support the BC’s Stand Alone Functionality requirement is not allowed.

2. Point expansion devices shall be mounted in packaged equipment enclosures, or locking wall mounted enclosure in a readily accessible location. Identify panel enclosure with the entire point address of point expansion device(s) on an engraved phenolic or micarta nameplate.
3. The owner shall approve the location of point expansion devices mounted above finished ceiling prior to installation. An owner approved ceiling tag shall identify the specific location of the point expansion device location.

4. Each point expansion device shall be identified in the database with the location of where the device is physically installed to allow the owner to service these devices when needed. The owner shall approve the final method identifying the locations with the available software options.

2.04 ADVANCED APPLICATION SPECIFIC CONTROLLER (AAC) AND APPLICATION SPECIFIC CONTROLLER (ASC)

A. General Requirements:
   1. AACs and ASCs shall provide intelligent, standalone control of HVAC equipment. Each unit shall have its own internal RAM, non-volatile memory and will continue to operate all local control functions in the event of a loss of communications on the ASC LAN or sub-LAN.

   2. AACs and ASCs shall include sufficient memory to perform the specific control functions required for its application and to communicate with other devices.

   3. Each AAC and ASC must be capable of stand-alone direct digital operation utilizing its own processor, non-volatile memory, input/output, minimum eight (8) bit A to D conversion, voltage transient and lightning protection devices. All volatile memory shall have a battery backup of at least fifty (50) hours with a battery life of five (5) years.

   4. All point data; algorithms and application software within an AAC /ASC shall be modifiable from the Operator Workstation.

   5. AAC and ASC Input-Output Processing:
      a. Digital Outputs (DO): Outputs shall be rated for a minimum 24 VAC or VDC, 1 amp maximum current. Each shall be configurable as normally open or normally closed. Each DO shall be discrete outputs from the AAC/ASC’s board (multiplexing to a separate manufacturer’s board is unacceptable). Provide suppression to limit transients to acceptable levels.

      b. Analog Inputs (AI): AI shall be 0-5 Vdc, 0-10Vdc, 0-20Vdc, and 0-20 mA. Provide signal conditioning, and zero and span calibration for each input. Each input shall be a discrete input to the BC’s board (multiplexing to a separate manufacturers board is unacceptable unless specifically indicated otherwise). A/D converters shall have a minimum resolution of eight to ten bits depending on application.

      c. Digital Inputs (DI): Monitor dry contact closures. Accept pulsed inputs of at least one per second. Source voltage for sensing shall be supplied by the BC and shall be isolated from the main board.

      d. Universal Inputs (UI-AI or DI): To serve as either AI or DI as specified above.
e. Electronic Analog Outputs (AO) as required by application:

1) Voltage mode, 0-5VDC and 0-10VDC; current mode (4-20 mA). Provide zero and span calibration and circuit protection. Pulse Width Modulated (PWM) analog via a DO and transducer is acceptable only with Owner approval (Generally, PWM will not be allowed on loops with a short time constant such as discharge temperature loops, economizer loops, pressure control loops and the like. They are generally acceptable for standard room temperature control loops.).

2) Where PWM is allowed, transducer/actuator shall be programmable for normally open, normally closed, or hold last position and shall allow adjustable timing. Each DO shall be discrete outputs from the BC’s board (multiplexing to a separate manufacturers board is unacceptable).

3) D/A converters shall have a minimum resolution of eight (8) bits.

B. Terminal Unit Controllers:

1. Terminal unit controllers controlling damper positions to maintain a quantity of supply or exhaust air serving a space shall have an automatically initiated function that resets the volume regulator damper to the fully closed position on a scheduled basis.

2. The controllers shall initially be set up to perform this function once every 24 hours. The purpose of this required function is to reset and synchronize the actual damper position with the calculated damper position and to assure the damper will completely close when commanded.

3. The software shall select scheduled terminal units randomly and shall not allow more than 5 percent of the total quantity of controllers in a building to perform this function at the same time. When possible the controllers shall perform this function when the supply or exhaust air system is not operating or is unoccupied.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. All Division 25 installation including but not limited to, cable and wiring, grounding, raceway and conduit, electrical circuit and panel identifications, wiring devices, and lighting shall comply with Division 26 installation requirements. In addition to the Division 26 requirements, contractor shall label panel board name and circuit number in an owner approved manner at each BAS field panel, control cabinet, or point of termination in which a 120VAC control circuit is utilized.
D. Figure A (below) illustrates the required layout of a Building Automation Panel in retrofit construction.

3.02 HARDWARE APPLICATION REQUIREMENTS

A. General:
   1. The functional intent of this Specification is to allow cost effective application of manufacturers standard products while maintain the integrity and reliability of the control functions.

   2. A Building Controller as specified above is generally fully featured and customizable whereas the AAC/ASC refers to a more cost-effective unit designed for lower-end applications. Specific requirements indicated below are required for the respective application. Manufacturer may apply the most cost-effective unit that meets the requirement of that application.

B. Standalone Capability:
   1. Each Control Unit shall be capable of performing the required sequence of operation for the associated equipment.
2. All physical point data and calculated values required to accomplish the sequence of 
operation shall originate within the associated CU with only the exceptions enumerated 
below. Listed below are functional point data and calculated values that shall be allowed 
to be obtained from or stored by other CUs or SDs via LAN.

C. Where associated control functions involve functions from different categories identified below, 
the requirements for the most restrictive category shall be met.

D. Application Category 0 (Distributed Monitoring):
   1. Applications in this category include the following:
      a. Monitoring of variables that are not used in a control loop, sequence logic, or safety.
   2. Points on BCs, AACs, and ASCs may be used in these applications as well as SDs 
      and/or general-purpose I/O modules.
   3. Where these points are trended, Contractor shall verify and document that the network 
      bandwidth is acceptable for such trends and is still capable of acceptable and timely 
      control function.

E. Application Category 1 (Application Specific Controller):
   1. Applications in this category include the following:
      a. Fan Coil Units.
      b. Airflow Control Boxes (VAV and Constant Volume Terminal Units).
      c. Miscellaneous Heaters.
      d. Unitary equipment <15 tons (Package Terminal AC Units, Package Terminal Heat 
         Pumps, Split-System AC Units, Split-System Heat Pumps, Water-Source Heat 
         Pumps).
      e. Induction Units.
      f. Dual Duct Zone Dampers.
   2. Standalone Capability:
      a. Provide capability to execute control functions for the application for a given setpoint 
         or mode, which shall generally be occupied mode control.
      b. Only the following data (as applicable) may be acquired from other controllers via 
         LANs. In the event of a loss of communications with any other controller, or any fault 
         in any system hardware that interrupts the acquisition of any of these values, the ASC 
         shall use the last value obtained before the fault occurred.
      c. If such fault has not been corrected after the specified default delay time, specified 
         default value(s) shall then be substituted until such fault has been corrected.

<table>
<thead>
<tr>
<th>Physical/Virtual Point</th>
<th>Default Value</th>
</tr>
</thead>
</table>
Physical/Virtual Point | Default Value
--- | ---
Scheduling Period | Normal
Morning Warm-Up | Off (cold discharge air)
Load Shed | Off (no shedding)
Summer/Winter | Winter
Trend Data | N/A

3. Mounting:
   a. ASCs that control equipment located above accessible ceilings shall be mounted on the equipment in an accessible enclosure and shall be rated for plenum use.
   b. ASCs that control equipment mounted in a mechanical room may either be mounted in, on the equipment, or on the wall of the mechanical room at an adjacent, accessible location.
   c. ASCs that control equipment mounted outside or in occupied spaces shall either be located in the unit or in a proximate mechanical/utility space.
   d. BAS Provider may furnish ASCs to the terminal unit manufacturer for factory mounting.

4. LAN Restrictions: For networks operating at 38.4 kbps or less, limit the number of nodes on the network to meet all system performance criteria and to no more than 80 percent of the maximum recommended by the manufacturer. For networks operating at greater than 38.4 kbps limit the number of nodes on the network to meet all system performance criteria up to the maximum recommended by the manufacturer.

F. Application Category 2 (General Purpose Terminal Controller):
   1. Applications in this category include the following:
      a. Unitary Equipment $\geq$ 15 tons (Air Conditioners, Heat Pumps, Packaged Heating/Cooling Units, and similar).
      b. Small, Constant Volume Single Zone Air Handling Units.
      c. Constant Volume Pump Start/Stop.
      d. Miscellaneous Equipment (Exhaust Fan) Start/Stop.
      e. Miscellaneous Monitoring (not directly associated with a control sequence and where trending is not critical).
   2. Standalone Capability:
      a. Only the following data (as applicable) may be acquired from other ASCs via LANs.
      b. In the event of a loss of communications with any other ASCs, or any fault in any system hardware that interrupts the acquisition of any of these values, the AAC/ASC shall use the last value obtained before the fault occurred.
c. If such fault has not been corrected after the specified default delay time, specified default value(s) shall then be substituted until such fault has been corrected.

<table>
<thead>
<tr>
<th>Physical/Virtual Point</th>
<th>Default Delay Time</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outside Air Temperature</td>
<td>3 minutes</td>
<td>80°F</td>
</tr>
<tr>
<td>Outside Air Humidity</td>
<td>3 minutes</td>
<td>60% RH</td>
</tr>
<tr>
<td>Outside Air Enthalpy</td>
<td>3 minutes</td>
<td>30 Btu/lb</td>
</tr>
<tr>
<td>Trend Data</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Cooling/Heating Requests</td>
<td>3 minutes</td>
<td>None</td>
</tr>
</tbody>
</table>

3. Mounting:
   a. ASCs that control equipment located above accessible ceilings shall be mounted on the equipment and shall be rated for plenum use.
   b. ASCs that control equipment located in occupied spaces or outside shall either be mounted within the equipment enclosure (responsibility for physical fit remains with the Contractor) or in a near by mechanical/utility room in which case it shall be enclosed in a NEMA 1, locking enclosure.

4. LAN Restrictions: Limit the number of nodes servicing any one of these applications on the AAC/ASC LAN to 80 percent capacity on new installed LANs.

G. Application Category 3 (Advanced Application Controller):
   1. Applications in this category include the following:
      a. Steam Pressure Reducing Station Control.
      b. Steam Converter Control.
      c. Large Constant Volume Air Handlers.
      d. VAV Air Handlers.
      e. Dual Duct Air Handlers.
      f. Multizone Air Handlers.
      g. Self-Contained VAV Units.
      h. Air Handlers serving critical areas.
      i. Central Cooling Plant.
      j. Central Heating Plant.
      k. Cooling Towers.
      l. Sequenced or Variable Speed Pump Control.
      m. Local Chiller Control (unit specific).
n. Campus Loop Chilled Water Control.

2. BCs shall be used in these applications.

3. LAN Restrictions: Comply with Part Two requirements, Stand-Alone Functionality.

3.03 CONTROL UNIT REQUIREMENTS

A. Refer to Section 25 00 10 for requirements pertaining to control unit quantity and location.

END OF SECTION 25 14 10