

SECTION 230905 - BAS SOFTWARE AND PROGRAMMING

PART I. GENERAL

I.1 SECTION INCLUDES

- A. System Software
- B. Programming Description
- C. Control Algorithms
- D. Energy Management Applications
- E. Password Protection
- F. Data Acquisition and Storage
- G. Operator Interface
- H. Point Structuring

I.2 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Section *(Insert Applicable Specification Section)* - Basic Mechanical Requirements
- C. Section 230900 - Building Automation System (BAS) General
- D. Section 230901 - BAS Basic Materials, Interface Devices, and Sensors
- E. Section 230903 - BAS Field Panels
- F. Section 230904 - BAS Communications Devices
- G. Section *{Insert Applicable Specification Section(s)}* – Sequences of Operation
- H. Section 230801 - BAS Commissioning

I.3 DESCRIPTION OF WORK:

- A. Fully configure systems and furnish and install all software and programming for a complete and fully functioning system as specified.
- B. Refer to *Section 230900 - Building Automation System (BAS)* for general requirements as well as requirements for interface with the UNC WAN
- C. Refer to *Section 230993 - Sequence of Operation* for specific sequences of operation for controlled equipment.

I.4 LICENSING

(Delete licensing requirement for software that UNC has a site license for)

- A. Provide or upgrade all licensing for all software packages at required workstations. BAS licensing shall allow unlimited access to all aspects of the system including

system access, LCSs, points, programming, etc. No restrictions shall be placed on the licensing. All programming environment, networking, and any other software used by the Contractor to install the system or needed to operate the system to its full capabilities shall be licensed and provided to the Owner.

- B. All software should be available on the LCS's provided, and on all Laptop Computers, if specified. Hardware and software keys to provide all rights shall be installed on all LCS. At least 2 sets of CDs shall be provided with backup software for all software provided, so that the Owner may reinstall any software as necessary. Include all licensing for LCS operating systems, and all required third-party software licenses.
- C. Provide licensing and original software copies for each LCS.
- D. In the last month of the warranty period, upgrade all software and firmware packages to the latest release (version) in effect at the end of the Warranty Period.
- E. Refer to *Section 230900 - Building Automation System (BAS) General* for further requirements.

PART II. PRODUCTS

II.1 SYSTEM SOFTWARE-GENERAL

- A. **Functionality and Completeness:** The Contractor shall furnish and install all software and programming necessary to provide a complete and functioning system as specified. The Contractor shall include all software and programming not specifically itemized in these Specifications, which is necessary to implement, maintain, operate, and diagnose the system in compliance with these Specifications.
- B. **Configuration:** The software shall support the system as a distributed processing network configuration.

II.2 CONTROLLER SOFTWARE

- A. All bindings, SNVT's, configuration values, addresses, calibration values, parameters, variables, tuning values, gains, test values, etc. for all software, programs, network configurations etc. shall be exposed and be available for setup, manipulation, adjustment, calibration, testing, etc. at the LCS and POT's for use as allowed via applicable password protection for all controllers and devices throughout the entire BAS.
- B. **PCU Software Residency:** Each PCU as defined below shall be capable of control and monitoring of all points physically connected to it. All software including the following shall reside and execute at the PCU:
 - 1. Real-Time Operating System software
 - 2. Real-Time Clock/Calendar
 - 3. PCU diagnostic software
 - 4. LAN Communication software/firmware
 - 5. Direct Digital Control software
 - 6. Energy Management software
 - 7. I/O (physical and virtual) database

8. Supervisory Logic software and algorithms

- C. **Stand Alone Capability:** The PCU shall continue to perform all functions independent of a failure in other PCUs or other communication links to other PCUs. Runtime totalization shall be available on all digital input points that monitor electric motor status. Refer also to Section 230903 for other aspects of stand alone functionality.
- D. **Operating System:** Controllers shall include a real-time operating system resident in ROM. This software shall execute independently from any other devices in the system. It shall support all specified functions. Refer also to Section 230903 for other aspects of the controller's operating system.
- E. **Network Communications:** Each controller shall include software/firmware that supports the networking of CUs on an ANSI 709.1 control network with ANSI 709.3 (TP/FT-10) media. Operator/System communication software shall allow point interrogation, adjustment, addition/deletion, and programming while the controller is on line and functioning without disruption to unaffected points. The software architecture shall allow networked controllers to share selected physical and virtual point information throughout the entire system.
- F. **Point Database/Summary Table:** All points included in the typical equipment point list must be represented in a common, open protocol format. Naming conventions for these points and network addressing are discussed in Part III of this section. Point/system database creation and modification shall be via a user-friendly, menu-driven program. System software shall support virtual or logic point (points not representing a physical I/O) creation. Software shall support virtual points with all services specified herein. Database software shall support definition of all parameters specified in Part III of this section for a given point type. If database does not support all these parameters, software module shall be created and attached to the points which accomplish the respective function.
- G. **Diagnostic Software:** Controller software shall include diagnostic software that checks memory and communications and reports any malfunctions
- H. **Application Programs:** CUs shall support and execute application programs as more fully specified below:
 - 1. All Direct Digital Control software, Energy Management Control software, and functional block application programming software templates shall be provided in a 'ready-to-use' state, and shall not require (but shall allow) CPS programming.
 - 2. Line programs shall supply preprogrammed functions to support these energy management and functional block application algorithms. All functions shall be provided with printed narratives and/or flow diagrams to document algorithms and how to modify and use them.
- I. **Security:** Controller software shall support multiple level password access restriction as more fully specified below.
- J. **Direct Digital Control:** Controller shall support application of Direct Digital Control Logic. All logic modules shall be provided pre-programmed with written documentation to support their application. Provide the following logic modules as a minimum:
 - 1. Proportional-Integral-Derivative (PID) control with analog and floating output
 - 2. Two Position control (Hi or Low crossing with deadband)

3. Single-Pole Double-Throw relay
 4. Delay Timer (delay-on-make, delay-on-break, and interval)
 5. Hi/Low Selection
 6. Reset or Scaling Module
 7. Logical Operators (And, Or, Not, Xor)
- K. **Psychrometric Parameters:** Controller software shall provide preprogrammed functions to calculate and present psychrometric parameters (given temperature and relative humidity) including the following as a minimum: Enthalpy, Wet Bulb Temperature.
- L. **Updating/Storing Application Data:** Site-specific programming residing in volatile memory shall be uploadable/downloadable from an LCS connected to the ANSI 709.1 network. Initiation of an upload or download shall include all of the following methods; Manually, Scheduled, and Automatically upon detection of a loss or change.
- M. **Restart:** System software shall provide for orderly shutdown upon loss of power and automatic restart upon power restoration. Volatile memory shall be retained; outputs shall go to programmed fail (open, closed, or last) position. Equipment restart shall include a user definable time delay on each piece of equipment to stagger the restart.
- N. **Time Synchronization:** Software on the LCS computer shall be able to set the time and date in any device on the network that supports time-of-day functionality.
- O. **Misc. Calculations:** System software shall automate calculation of psychrometric functions, calendar functions, kWh/kW, and flow determination and totalization from pulsed or analog inputs, curve-fitting, look-up table, input/output scaling, time averaging of inputs and A/D conversion coefficients.

II.3 APPLICATION PROGRAMMING DESCRIPTION

- A. The application software shall be either user configurable or user programmable.
- B. This specification generally requires a programming convention that is logical, easy to learn, use, and diagnose. General approaches to application programming shall be provided by one, or a combination, of the following conventions:
1. **Point Definition:** provide templates customized for point type, to support input of individual point information.
 2. **Graphical Block Programming:** Manipulation of graphic icon 'blocks', each of which represents a subroutine, in a functional/logical manner forming a control logic diagram. Blocks shall allow entry of adjustable settings and parameters via pop-up windows. Provide a utility that shall allow the graphic logic diagrams to be directly compiled into application programs. Logic diagrams shall be viewable either off-line, or on-line with real-time block output values.
 3. **Functional Application Configuration:** Pre-programmed application specific programs that allow/require limited customization via 'fill-in-the-blanks' edit fields. Typical values would be setpoints gains, associated point names, alarm limits, etc.
 4. **Line Programming:** Textual syntax-based programming in a language similar to BASIC designed specifically for HVAC control. Subroutines or functions for

energy management applications, setpoints, and adjustable parameters shall be customizable, but shall be provided preprogrammed and documented.

- C. Provide a means for testing and/or debugging the control programs both off-line and on-line.

II.4 PASSWORD PROTECTION

- A. Multiple-level password access protection shall be provided on the LCS to allow the Owner's authorized BAS Administrator to limit capabilities as (s)he deems appropriate for each user, based upon an assigned user name with a unique password.
- B. All passwords for the system shall be provided to the Owner including administrator, dealer, or factory level passwords for the systems provided under this project.
- C. Passwords shall restrict access to all Control Units.
- D. Each user name shall be assigned to a discrete access level. A minimum of five levels of access shall be supported. Alternately, a comprehensive list of accessibility/functionality items shall be provided, to be enabled or disabled for each user.
- E. A minimum of 250 user names shall be supported and programmed per Owner's direction.
- F. Operators shall be able to perform only those commands available for the access level assigned to their user name.
- G. User-definable, automatic log-off timers of from 1 to 60 minutes shall be provided to prevent operators from inadvertently leaving interface device software on-line.

II.5 LOCAL CONTROL SYSTEM SOFTWARE

- A. Software shall facilitate user-friendly interface to all aspects of the System Software specified above. The intent of this specification is to require a package that provides for intuitive operation and modification of the systems without extensive training and experience. It shall facilitate logical and simple system interrogation, modification, configuration, and diagnosis.
- B. Operating system software provided by UNC shall be *Microsoft Windows XP Professional*. Vendor should contact UNC regarding modifications and restrictions to OS.

II.6 POINT STRUCTURING AND NAMING

- A. **General:** The intent of this section is to require a consistent means of naming points across the UNC EMCS VLAN. Contractor shall configure the systems from the perspective of the UNC EMCS VLAN, not solely the local project. The following requirement establishes a standard for naming points and addressing Buildings, Networks, Devices, Instances, and the like. The convention is tailored towards the UNC EMCS VLAN and as such, the interface shall always use this naming convention, any deviations from this naming convention shall be approved by the Owner. Each controller shall have English language descriptors for all system points, variables, parameters etc. located and accessible from the controller memory. All point naming shall match between all system files and record documents.

B. Point Summary Table

1. The term 'Point' is a generic description for the class of object represented by analog and binary inputs, outputs, and values.
2. With each schematic, Contractor shall provide a Point Summary Table listing:
 - a) Building Designator
 - b) Building Name
 - c) System Description
 - d) Point ID
 - e) Point Type
 - f) Full point name (see Point Naming Convention paragraph)
 - g) English language point description
 - h) Node address (Domain, Subnet, Node)
 - i) Node ID
 - j) SNVT type
 - k) SNVT name
 - l) Engineering units
 - m) Alarm limits, if any
3. All additional fields shall be appended to each row. Point Summary Table shall be provided in both hard copy and in electronic format
4. Point Summary Table shall also illustrate Network Variables/LonWorks Bindings.
5. The BAS Contractor shall coordinate with the Owner's representative and compile and submit a proposed Point Summary Table for review prior to any object programming or project startup.
6. The Point Summary Table shall be kept current throughout the duration of the project by the Contractor as the Master List of all points for the project. Project closeout documents shall include an up-to-date accurate Point Summary Table. The Contractor shall deliver to the Owner the final Point Summary Table prior to final acceptance of the system. The Point Summary Table shall be used as a reference and guide during the commissioning process.
7. The Point Summary Table shall contain all data fields on a single row per point. The Point Summary Table is to have a single master source for all point information in the building that is easily sorted and kept up-to-date. Although a relational database of NodeID-to-point information would be more efficient, the single line format is required as a single master table that will reflect all point information for the building. The point description shall be an easily understandable English-language description of the point.

Point Summary Table Example

(Transpose for a single point per row format)

Sample: 0037CHWVLV001AO

Point	Description	Sample
AAA	Building Designator	0037 (UNC 4 digit Building Code)
	Building Name	Peabody Building
BBBBBB	System Designator	CHWVLV (6 digits)
	System Description	Chilled Water Valve
XXXX	Point ID	001A (3 digits, one letter – The first 3 characters are to be numbers, the last character is to be a letter)
	Point ID	AHU-A1
YYY	Point Type	O (3 digits)
	*Point Name	0037.CHWVLV001A.O
	*Point Description	Peabody Building, Chilled Water Valve, AHU-A1, Output
	Domain, Subnet, Node Address	1, 27, 42
	SNVT Type	SNVT_switch
	Node ID	0x0123456789abc
	Point Type	AO
	SNVT Name	AHU-A1-CC-V
	Engineering Units	Volts, mA,
	Network Variable?	True

C. Point Naming Convention

1. All point names shall adhere to the format as established below. Said objects shall include all physical I/O points, calculated points used for standard reports, and all application program parameters. For each BAS object, a specific and unique name shall be required.
2. For each point, (4) distinct descriptors shall be linked to form each unique object name: Building Designator, System Designator, Point ID, Point Type. The allowed characters are alphanumeric (upper and lower case letters and numbers only). Reference the paragraphs below for an example of these descriptors.
3. The Owner shall designate the *Building Designator*. The *System Designator* shall further define the object in terms of Chilled Water Pump, Return Fan, Steam Valve, or other component. The *Point ID* shall define the equipment tag; e.g., Fan, Air Handler, or other equipment. The *Point Type* shall define the software type or function associated with the equipment; e.g., temperature, pressure, alarm, setpoint, etc.
4. A consistent object (point) naming convention shall be utilized to facilitate familiarity and operational ease across UNC EMCS VLAN. Inter-facility consistency shall be maintained to ensure transparent operability to the greatest

degree possible. The table below details the object naming convention and general format of the descriptor string. A maximum of 16 characters shall be used.

AAAA - Building Identifier Requirements

Tag	Description
0037	Peabody Building
0391	Ram's Head Center Dining Building
0217	Taylor Hall
####	Future
####	Future
####	Future

BBBBBB – System Designator Requirements

Tag	Description	Tag	Description
CHWBLD	Chilled Water Building	HTGOC:	Occupied Heating
CHWBR	Chilled Water Building Return	HTGSTG	Heating Stage
CHWBS	Chilled Water Building Supply	HTGUN	Heating Unoccupied
CHWCAM	Chilled Water Campus	HTGVLV	Heating Valve
CHWCR	Chilled Water Campus Return	HUM	Humidification
CHWCS	Chilled Water Campus Supply	HUMVLV	Heating Valve
CHWDP	Chilled Water Differential Pressure	LOWLIM	Low Limit
CHWPCR	Chilled Water Process Return	MAIR	Mixed Air
CHWPCS	Chilled Water Process Supply	MKWVLV	Make Up Water Valve
CHWPMP	Chilled Water Pump	MOTDET	Motion Detector
CHWSYS	Chilled Water System	OADMP	Outside Air Damper
CHWVLV	Chilled Water Valve	OAIR	Outside Air
CLG	Cooling	OCC	Occupied
CLGOC	Occupied Cooling	OVRLCL	Local Override
CLGSTG	Cooling Stage	PCWCGR	Process Water Cooling Return
CLGUN	Cooling Unoccupied	PCWCGS	Process Water Cooling Supply
CLGVLV	Cooling Valve	PCWDP	Process Water Differential Pressure
CO2	Carbon Dioxide Sensor	PCWPMP	Process Water Pump
DEHUM	Dehumidification	PCWVFD	Process Water Pump VFD
DMP	Damper	PCWVLV	Process Water Valve
EHTGST	Electric Heating Stage	RAIR	Return Air
ENTOA	Entering Outside Air	RFAN	Return Air Fan
FAN	Fan	RHVLV	Reheat Valve
FLSWTH	Float Switch	ROOM	Room
FANPAR	Parallel Fan	RVFD	Return Air Fan VFD
FILF	Final Filter	SAIR	Supply Air
FILHEPA	HEPA Filter	SAIRTM	Supply Air Terminal
FILOA	Outside Air Filter	SATOCC	Supply Air Terminal Occupied
FILP	Pre-Filter	SATUNC	Supply Air Terminal Unoccupied
HHWCR	Heating Hot Water Common Return	SFAN	Supply Fan
HHWCS	Heating Hot Water Common Supply	SMOKE	Smoke Mode
HHWPMP	Heating Hot Water Pump	STEAM	Steam
HHWRET	Heating Hot Water Return	STMVLV	Steam Valve
HHWSUP	Heating Hot Water Supply	STPRS	Static Pressure
HHWSYS	Heating Hot Water System	SVFD	Supply Air Fan VFD
HTG	Heating	VFD	Variable Frequency Drive

XXX – Point Type Requirements

Tag	Description
ALM	Alarm
C	Command
DP	Differential Pressure
F	Flow
H	Humidity
HLS	High Limit Status
HSP	High Setpoint
LLS	Low Limit Status
LSP	Low Setpoint
LVL	Level
O	Output
P	Pressure
S	Status
SP	Setpoint
TE	Temperature

YYY – Point Data Requirements

D A T A V A L U E	POINT TYPE	UNIT TAG	DESCRIPTION
XX.X	Temperature	DEGF	Degree Fahrenheit
XX.XX	Pressure	PSI	Pounds per Square Inch
XX.XX	Pressure	INWG	Inches Water Gage
XX.XX	Pressure	PSID	Pounds per Square Inch Differential
XX.X	Steam Flow	LBS/HR	Pounds per Hour
XX.X	Water Flow	GPM	Gallons per Minute
XXX	Air Flow	CFM	Cubic Feet per Minute
XX.X	Relative Humidity	%RH	Percent of Relative Humidity
XX.X	Output Command Indication	%	Percent
XX.X	Electrical Rate	KW	Kilowatts
XX	Total Energy Usage	KWHR	Kilowatts-hr
XX.X	Speed	FPS	Feet per second
XX.X	Total Energy Usage	BTU	British Thermal Unit
XX.X	Rate of Energy	BTU/HR	BTU per hour
XX.X	Total Steam Usage	KLBS	Kilo-pounds (1000 pounds)

XX.X	Tonnage Rate	TONS	Tons of Refrigeration
XX.X	Total Tonnage Usage	KTONHR	Kilo-tons per hour
XX.X	VFD Speed	HZ	Hertz

D. Device Addressing Convention:

1. Network numbers and SNVT names shall be unique throughout the building control network.
2. All assignment of network and domain numbers shall be provided by UNC.
3. Each Network number shall be unique throughout all facilities.

PART III. EXECUTION**III.1 SYSTEM CONFIGURATION**

- A. Contractor shall thoroughly and completely configure BAS system software, supplemental software, network communications, LCS, and portable operators terminal.

III.2 SITE-SPECIFIC APPLICATION PROGRAMMING

- A. Provide all database creation and site-specific application control programming as required by these Specifications, national and local standards and for a fully functioning system. Contractor shall provide all initial site-specific application programming and thoroughly document programming. Generally meet the intent of the written sequences of operation. It is the Contractor's responsibility to request clarification on sequence issues that require such clarification.
- B. All site-specific programming shall be fully documented and submitted for review and approval, both prior to downloading into the panel, at the completion of functional performance testing, and at the end of the warranty period.
- C. All programming, user interfaces and data files must be maintained in a logical system of directories with self-explanatory file names. All files developed for the project will be the property of the Owner and shall remain on the workstation(s)/server(s) at the completion of the project.

III.3 LCS PASSWORD SETUP

- A. Set up the following password levels to include the specified capabilities:
 1. Level 1: (Owner's BAS Administrator)
 - a) Level 2 capabilities
 - b) View, add, change and delete user names, passwords, password levels
 - c) All unrestricted system capabilities including all network management functions.
 2. Level 2: (Programmer)
 - a) Level 3 capabilities
 - b) Configure system software
 - c) Modify control unit programs
 - d) Essentially unrestricted except for viewing or modifying user names, passwords, password levels
 3. Level 3: (Senior HVAC Technician)

- a) Level 4 capabilities
 - b) Change SNVTs
 - c) Change configuration properties via LNS plugins
 - d) Exit BAS software to use third party programs
- 4. Level 4: (HVAC Technician)
 - a) Read-only access.
- B. Contractor shall assist Owner's operators with assigning user names, passwords and password levels.

III.4 POINT PARAMETERS

- A. Provide the following minimum programming for each analog input:
 - 1. Name
 - 2. Address
 - 3. Scanning frequency or COV threshold
 - 4. Engineering units
 - 5. Offset calibration and scaling factor for engineering units
 - 6. Default value to be used when the actual measured value is not reporting. This is required only for points that are transferred across the control network and used in control programs residing in control units other than the one in which the point resides. Events causing the default value to be used shall include failure of the control unit in which the point resides, or failure of any network over which the point value is transferred.
 - 7. Selectable averaging function that shall average the measured value over a user selected number of scans for reporting.
- B. Provide the following minimum programming for each analog output:
 - 1. Name
 - 2. Address
 - 3. Output updating frequency
 - 4. Engineering units
 - 5. Offset calibration and scaling factor for engineering units
 - 6. Output Range
 - 7. Default value to be used when the normal controlling value is not reporting.
- C. Provide the following minimum programming for each digital input:
 - 1. Name
 - 2. Address
 - 3. Engineering units (on/off, open/closed, freeze/normal, etc.)
 - 4. Debounce time delay
 - 5. Reporting of each change of state, and memory storage of the time of the last change of state

6. Totalization of on-time (for all motorized equipment status points), and accumulated number of off-to-on transitions.
- D. Provide the following minimum programming for each digital output:
1. Name
 2. Address
 3. Output updating frequency
 4. Engineering units (on/off, open/closed, freeze/normal, etc.)
 5. Direct or Reverse action selection
 6. Minimum on-time
 7. Minimum off-time
 8. Status association with a DI and failure alarming (as applicable)
 9. Reporting of each change of state, and memory storage of the time of the last change of state.
 10. Totalization of on-time (for all motorized equipment status points), and accumulated number of off-to-on transitions.
 11. Default value to be used when the normal controlling value is not reporting.
 12. **HOA Switch Tampering Alarms:** The Sequences of Operation are based on the presumption that motor starter Hand-Off-Auto (HOA) switches are in the 'Auto' position. If a motorized equipment unit starts without a prior start command from the BAS, (as sensed by status sensing device), then BAS shall perform the remaining sequence as specified.

END OF SECTION 230905