



**Office of Capital Planning
and Project Management**

DIVISION 25

**INTEGRATED
AUTOMATION**

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25 00 00 BUILDING AUTOMATION SYSTEMS

There are three Building Automation Systems (BAS) architectures that shall be acceptable to UIC, defined below as System A, B, or C. Which system to be used shall be job specific and is entirely the choice of the Office of Capital Planning and Project Management Controls Staff. These specifications shall be in addition to the requirements for All Systems, listed below.

1. System A: A system comprised entirely of Tridium AX 6xx and 7xx level controllers that serve up the user interface as well as directly control all functions for major equipment (AHUs, central plant etc.) using Tridium I/O expansion modules.
2. System B: A system comprised of Tridium AX 6xx and 7XX level controllers that serve up the user interface and are primarily used as supervisory level controllers to interface to 3rd party field level controllers such as VAV boxes, AHU controllers, chillers etc. Acceptable manufacturers for these field level controllers shall be Alerton, Distech, KMC Open Bacnet, AAM Open Bacnet, and Honeywell Spyder with fully open Bacnet License.
3. System C: A system comprised entirely of Alerton field level and supervisory level controllers, connected to the existing Alerton Envision front end.

Specific system specification requirements are:

1. **System A - Tridium:**
 - a. Room numbers shown on graphic screens shall be dynamically linked to the description tag of the object in the Tridium database that represents that VAV serving that room.
 - b. Tridium Building automation system license:
 - i. All Tridium controllers shall be provided with a fully open license that follows the format shown below. Where a field is shown as an asterisk "*" it shall be understood to mean that parameter is open to all possible values.
 - ii. All features shown below shall be included in every Tridium device installed.
 - iii. Where a feature below is shown with an expiration or limit as "never" or "none" so shall those parameters be for any license for any Tridium device provided.

```

feature name="about" owner="UIC" project="UIC"/
feature name="brand" brandId="brand" accept.station.in="*" accept.station.out="*"
accept.wb.in="*" accept.wb.out="*" /
feature name="bacnet" expiration="never" device.limit="none"
export="true"
history.limit="none" point.limit="none" schedule.limit="none"/
feature name="email" expiration="never"/
feature name="lonworks" expiration="never" device.limit="28"
history.limit="none" point.limit="none" schedule.limit="none"/
feature name="mstp" expiration="never" port.limit="4"/
feature name="ndio" expiration="never" device.limit="none"
history.limit="none" point.limit="none" schedule.limit="none"/
feature name="niagaraDriver" expiration="never"
device.limit="none"
history.limit="none" point.limit="none" schedule.limit="none"/
feature name="obixDriver" expiration="never" device.limit="27"
export="true"
foreignDevice.limit="27" foreignHistory.limit="none"
foreignPoint.limit="none"
foreignSchedule.limit="none" history.limit="none" point.limit="none"
schedule.limit="none"/
feature name="serial" expiration="never"/
feature name="station" expiration="never"/
feature name="web" expiration="never" ui="true" ui.wb="true"/

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- iv. The Tridium device shall come with the most current revision of software released by Tridium.
- v. A one year warranty shall be provided a part of any TCC contract by the TCC at no extra charge to the University. This warranty shall include all software and labor to implement all Tridium issued revisions and updates for one year from the date of system acceptance by UIC OCP.
- c. Programmer must be certified in Niagara AX product programming, and must be a resident employee from an office within 50 miles of the job site. Temporarily importing an employee from a further office just to do programming shall be unacceptable, as it will cause warranty coverage issues.
- d. The user graphics shall be distributed among each building's individual JACE supervisors/controllers, with a central server used primarily for long term trend storage and as a user gateway across campus systems. Each building may have

a different approved manufacturers' field controllers as VAVs or fan controllers, etc; however these systems shall be integrated back into a Tridium JACE as a supervisor and web server engine.

2. **System B:** - Tridium as supervisory level with 3rd party field controllers.
 - a. See System A (above) and also All Systems (below) requirements.
3. **System C:** - Alerton only:
 - a. The Alerton Envision central computer will provide the operator with a point of entry to view and store the data that is required for efficient system operation.
 - i. Front End Computer System: The software shall include a real-time multi-user operating system.
 - ii. Operator Interface with the system will have as a minimum the following:
 1. Operator access
 2. User control over system configuration
 3. Facility management functions
 4. Energy management control functions
 - iii. Each category of software shall consist of interactive software modules utilizing standard software packages available on the open market and not proprietary to any one equipment provider. Each module shall have an associated priority level and shall execute as determined by the program controller as defined in the real-time operating system.
 - iv. The Software shall use English language for each point identification. These shall be full English words with the option to abbreviate at the user's discretion. The system shall accept multiple English language identifiers as well as foreign language identifiers for each point on the system. These shall be known as "User Names". In addition, system formatting shall be provided which shall allow for software grouping of related points.
 - v. The system shall operate on a Format basis, regardless of the manner of hardware configuration in which data is acquired. A system of points shall consist of a logical grouping of data points related to a piece of mechanical equipment, and energy distribution system, or an architectural area. For example, in some cases it may be desired to display a space temperature with its associated air handling unit, and in other cases to display all space temperatures on a floor or in a building as a single system.

- vi. The Software shall allow such determinations to be made without regard to physical hardware location(s). Likewise, the system shall accommodate future changes of system grouping and operations without field hardware changes.
 - vii. User names, point descriptors, and engineering units shall be operator definable on a per point basis. Systems which use fixed vendor-supplied look-up tables are not acceptable.
 - viii. User Control Over Configuration:
 - 1. The intent of this standard is to provide a system which shall allow the University to independently do its own modifications to the system.
 - b. It is the intention of the University to have automated and control systems which meet the requirements of BACnet communication according the ASHRAE standard SPC- 135A/95 at every level of the device network.
 - c. All controllers performing algorithmic calculations and control of the Air Handling and other primary mechanical equipment shall have BACnet Class 3 performance as a minimum.
4. **ALL SYSTEMS:** The following requirements shall apply to all systems.
- a. A trunk cable riser diagram showing Digital System Controllers/Security Digital System Controllers/Fire Digital System controllers (DSC/SDSC/FDSC) locations, and all trunk data conductors shall be furnished.
 - b. TCC shall provide all field controller programming tools, network management tools, and any other software that would be used to commission all controllers used in that project. All software provided shall be licensed to UIC, shall be fullfeatured (not a limited or trial version) and shall not expire, and shall be provided on CD media. At the owner's (UIC-OCP) discretion, upgrades to existing software may be allowed where UIC already owns sufficient copies of the base software.
 - c. The programming tool for field controller must be object oriented and shall use a graphical interface. This tool shall be self-documenting into either ACAD or VISIO format.
5. The building automation system shall be web based with the following features as minimum:
- a. System shall provide real-time navigation through the system and auto listing of all BACnet devices on the network and their objects.

- b. System shall provide view and edit operations of most objects (I/O, variables, schedules, trend) including Auto/Manual, set point, descriptions, etc.
 - c. Users shall be able to view and acknowledge active alarms.
 - d. Alarm notification can be e-mailed.
 - e. System shall provide the same level of security as the on-site operator's terminal.
 - f. System shall allow unlimited concurrent users.
6. All materials and equipment used shall be standard components, regularly manufactured for this or other systems and not custom designed. All systems and components shall have been thoroughly tested and proven in actual use for at least two years.
7. The sequence of operation for every system shall be included in the Building Automation System on the same screen showing that system graphic. There shall be a sub-link on the screen to direct all users to such sequence of operation.
8. Each Graphic screen shall have a text screen associated with it, and the user will be able to switch back and forth between each unit's graphic and text screen via a hyperlink button.
9. All floor plan layouts shall be included in the building automation system. Access to the floor plan shall be through a sub link on the same screen showing the graphics of the HVAC serving that space. Building Automation Systems (BAS) performance requirements shall include the following applications:
- a. Heating, Ventilating and Air Conditioning Monitoring, Equipment and Lighting Control
 - b. Energy Management Routines
 - c. Future Fire Alarm connectivity through existing BAS
 - d. Miscellaneous Equipment Monitoring
10. A trunk cable riser diagram showing Digital System Controllers/Security Digital System Controllers/Fire Digital System controllers (DSC/SDSC/FDSC) locations, and all trunk data conductors shall be furnished.
11. Company shall provide programming editing tool for every project, for all databases and for programming field controllers and program shall be self-documenting by printout into either VISIO or ACAD format.
12. The programming tool for field controller must be object oriented and should use a graphical interface.

13. All BACnet devices shall include all hardware and software necessary to integrate the controls with the existing BACnet over Ethernet or IP network and meet the systems functional specification.
14. Any BACnet device that exists on a common BACnet inter-network must have a unique address, referred to as its Device Instance. The Chief Plant Operating Engineers Office shall establish the Device Instance numbering system.
15. The BAS shall be a computer based distribution system that shall monitor life safety, mechanical and electrical equipment status and have the capability of controlling certain mechanical, electrical and life safety system components. The architecture of the system shall be a distributed one in which the monitor/control function responsibility is located as close as possible to the monitored/controlled variable. These results in several levels of processing which can stand alone should the communication be lost to the next higher level of processing.
16. Equipment Control will be provided by programmable or application specific Controllers. All algorithms required for standalone operation of each control loop will be contained within the unique board. The controlled equipment will maintain its set points and logic regardless of centralized network communications.
17. All enclosed relays used with an indicating LED (like R.I.B's) shall use a printed label describing its functional state, i.e. **"ON to run"** or **"ON for alarm"**.
18. BAS shall monitor/control all the points and functions as listed below.
 - a. Inputs monitored or alarmed and output control functions.
 - b. Digital input indication signals from contacts associated with on-off, off-normal, normal or other indications initiated by making or breaking of the contacts.
 - c. Digital output signals which shall be two state control outputs, except as noted, e.g., on-off, open-close, start/stop. Momentary or a maintained state shall be noted as required.
 - d. Analog I/O signals which are continuously variable.
 - e. The schedule shall include calculations from software of functions monitored, e.g., BTU, kilowatts, etc., if requested by the University.
 - f. The schedule shall include totalization of variables within the software. This shall include totalization program requirements for on-line assignments.
19. The system shall be modular to allow change of function and operation in the field by plug-in module equipment and permit software change to expand the system capacity on full on-line basis.

20. The system shall include isolation, shielding, or filtering to eliminate interference from all external sources including, but not limited to radio signals, power conductors, etc.

21. Networking:

- a. Each control unit shall be capable of sharing point information with other such units, such that control sequences or control loops executed at one control unit may receive input signals from sensors connected to other units within the network. If the network communication link fails or the originating control unit malfunctions, the control loop shall continue to function using the last value received from the failed control unit. At no point in any control system is the campus ethernet network to be utilized as an integral component of the control system - the control system shall be designed to function normally per the sequence of operation without any campus ethernet network present. Where a Tridium system is used, a BACnet MSTP network (separate from any other MACnet MSTP network that connects to other field controllers) shall be run to every JACE controller, specifically for passing system data between controllers. Where an Alerton system is used, dedicated point-to-point ethernet or fieldbus cabling shall be used to connect supervisory level controllers, separate from other fieldbus networks. When using extra network cabling to pass critical data between controllers on a dedicated (non-campus) network is not feasible, other arrangements may be acceptable at UIC-OCP's discretion, like adding redundant sensors or using failsafe control logic.
- b. Failure of one control unit shall have no other effect upon any of the other units in the network.

22. The following is a list of manufacturers of materials and equipment that are known to have product that is Native BACnet at all levels of device communications. Only these manufacturers are considered acceptable. Manufacturers advocating gateways at different levels of their product line are not acceptable. Gateways and alternative methods of network communication are only considered acceptable when provided by the manufacturer of primary plant systems such as Variable Frequency Drives, Boilers, Packed Rooftop Equipment, Chillers, etc.

MATERIAL OR EQUIPMENT	MANUFACTURER
Native BACnet Temperature	Tridium, Distech, KMC
Control Systems	

23. Each Control Panel shall be capable of independently performing the following routines as a minimum:

- a. System graphic
- b. System on/off indication
- c. System day/night mode
- d. Supply fan on/off indication
- e. Return fan on/off indication
- f. Heating coil pump on/off indication
- g. Outside air temperature indication
- h. Mixed air temperature indication
- i. Fan discharge air temperature indication
- j. Fan discharge temperature control point adjustment
- k. Supply static pressure indication
- l. Supply static pressure control point adjustment
- m. Humidity sensor
- n. Enthalpy sensor
- o. System on/off auto switch position.
- p. System day/night/auto switch position.
- q. Supply fan on/off switch position.
- r. Return fan on/off/auto switch position.
- s. Heating coil pump on/off switch position.
- t. Time of day scheduling.
- u. Start/stop time optimization.
- v. Peak demand limiting.
- w. Duty cycling (temperature and/or time based).
- x. Enthalpy optimization.
- y. Supply air reset.
- z. Chilled water reset.
- aa. Hot water reset based on outdoor air temperature.
- bb. Event initiated programs.
- cc. Trending

24. The Control Panel shall support the creation, modification or removal of control algorithms while operating.

25. The Control Panel shall allow custom control algorithms to be created

- a. Locally within the Control Panel.

- b. Centrally within the front end computer and downloaded.
- c. By a personal computer (IBM compatible) and downloaded.

26. User Control Over Configuration:

- a. The intent of this standard is to provide a system which shall allow the University to independently do its own modifications to the system.
- b. All changes shall be done utilizing standard procedures and must be capable of being done while the system is on-line and operational. To aid an operator, intuitive operator interfaces shall be employed. The operator shall be required to simply click on the set-point, logical point or other controlled parameter to modify the system.
- c. The system shall have the minimum capability to allow the University to do the following:
 - i. Add and delete points.
 - ii. Modify any point parameter.
 - iii. Change, add or delete English language descriptors.
 - iv. Change, add or delete engineering units.
 - v. Change, add or delete points in start/stop programs, trend logs, etc.
 - vi. Select analog alarm limits.
 - vii. Adjust analog differentials.
 - viii. Create custom relationships between points.
- d. The BAS software shall support an unlimited number of nodes on the communication network.
- e. Once the hardware terminal devices are installed, the operator shall be able to modify the system software to accommodate the new or reconfigured devices.
- f. It shall be possible to limit the capabilities of any console on the system.
- g. It shall be possible to further assign on a per point basis the ability to command, display or alarm a point at a specific workstation.

27. Provision for facilities management functions shall be provided as a minimum.

28. Provision for Energy Management Control Functions shall be provided as a minimum for the purpose of optimizing energy consumption while maintaining occupant comfort.

29. Communication Software:

- a. The system shall include software for communication between all systems. The capabilities of this software shall include program to program communication, network virtual terminal capability, file transfer, remote command/batch file

submission and execution, remote resource access, downline system loading, downline task loading, and upline dumping.

- b. The software shall be consistent with ASHRAE Standard 135 and support the required BACnet system functionality as defined in the Standard.

30. Digital Systems Controller (DSC):

- a. The units shall maintain the programming and algorithms necessary to control independent mechanical systems. The Digital System Controller shall communicate over a local LAN connected to the System LAN at the individual control panels.
- b. These units shall connect directly to control unit through a local area network, providing additional local digital point capacity. All control programs shall reside within the associated control unit.
- c. Digital System Network (DSN):
 - i. Network Controllers shall be stand-alone, multi-tasking, multi-user, realtime digital control processors consisting of modular hardware with plug-in enclosed processors, communication controllers, power supplies and input/output point modules.
 - ii. Each Controller shall have sufficient memory to support its own operating system and databases, including:
 - 1. BAS Control processes
 - 2. Energy management applications
 - 3. Alarm management applications including custom alarm messages for each level alarm for each point in the system.
 - 4. Historical/trend data for points specified
 - 5. Maintenance support applications
 - 6. Custom processes
 - 7. Operator I/O
 - 8. Dial-up communications
 - iii. Each DDC Controller shall support any combination of industry standard inputs and outputs.
 - iv. As indicated in the point I/O schedule, the operator shall have the ability to manually override automatic or centrally executed commands at the DDC Controller via local, point discrete, on-board hand/off/auto operator override switches for digital control type points. Switches shall be mounted either within the DDC Controllers key-accessed enclosure,

or externally mounted with each switch keyed to prevent unauthorized overrides. Alternately, external relays with HOA function can be used, provided they are mounted in an orderly fashion inside aforementioned locking control panels and are wired back into controller inputs to show all relay HOA switch positions.

- v. DDC Controllers shall provide local LED status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device. Status indication shall be visible without opening the panel door.
- vi. Each DDC Controller shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all panel components. The DDC Controller shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication.
- vii. Isolation shall be provided at all peer-to-peer network terminations, as well as all field point terminations to suppress induced voltage transients consistent with IEEE Standards 587-1980, or latest edition.
- viii. In the event of the loss of normal power, there shall be an orderly shutdown of all DDC Controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.
 - 1. Upon restoration of normal power, the DDC Controller shall automatically resume full operation without manual intervention.
 - 2. Should DDC Controller memory be lost for any reason, the user shall have the capability of reloading the DDC Controller via the local port, via telephone line dial-in or from a network workstation PC.

31. Data Trunk:

a. Transmission Network:

- i. The system shall use an intelligent distributed communication network.
- ii. Transmission
 - 1. Network communications shall be of the ASHRAE 135 Standard

32. Definitions: The following abbreviations, acronyms and definitions are used in addition to those details found elsewhere in Contract Documents.

Actuator:	Control device to provide motion of valve or damper in response to control signal.
AI:	Analog Input
AO:	Analog Output
Analog:	Continuously variable state over stated range of values
ATC:	Automatic Temperature Control
Auto-Tune:	Software routine used to adjust tuning parameters based on historical data.
BAS:	Building Automation System
BCU:	Building Control Unit
CAV:	Constant Air Volume
CGS:	Color Graphic Software
DDC:	Direct Digital Control
DDCP:	Direct Digital Control Panel
Discrete:	Binary or digital state
DI:	Discrete Input
DO:	Discrete Output
EMCS:	Energy Management and Control System (Same as BAS)
FC:	Fail Closed position of control device or actuator. Device moves to closed position on loss of control signal or energy source.
FMS:	Facility Management System linking two or more BAS
FO:	Fail Open position of control device or actuator. Device moves to open position on loss of control signal or energy source.
HCP:	Host Control Panel
HOA:	Hand-Off-Auto
I/P:	Current to pneumatic transducer
Instrument:	Device used for sensing input parameters or used for actuation
LAN:	Local Area Network
LCD:	Liquid Crystal Display
LCP:	Local Control Processor
Modulating:	Movement of a control device through an entire range of values proportional to infinitely variable input values.
Motorized:	Control device with actuator.
NC:	Normally Closed position of switch after control signal is removed or dampers. normally closed position of manually operated valves or
NCP:	Network Control Processor

NO:	Normally Open position of switch after control signal is removed or normally open position of manually operated valves or dampers.
Node:	DDCP, user workstation, or other control device connected to communication's network.
Operator:	Same as actuator.
PC:	Personal Computer
Peer-to-Peer:	Mode of communication between controllers in which each device connected to network has equal status and each shares its database values with all other devices connected to network.
P:	Proportional control, control mode with continuous linear relationship between observed input signal and final controlled output element.
PHP:	Public Host Protocol
PI:	Proportional - Integral control, control mode with continuous proportional output plus additional change in output based on both amount and duration of change in controlled variable (Reset control).
PID:	Proportional - Integral - Derivative control, control mode with continuous correction of final controlled output element versus input signal based on proportional error, its time history (reset), and rate at which its changing (derivative).
Point:	Analog or discrete instrument with addressable database value.
PUC:	Programmable Unitary Controller
PUP:	Public Unitary Protocol
RAM:	Random Access Memory
RCU:	Remote Control Unit
Self-Tune:	Same as Auto-Tune

33. The HVAC temperature control hardware will be native BACnet. Native BACnet means that the database objects in the controller can be seen by other BACnet systems, and data can be exchanged between other BACnet devices without the need for a gateway.

34. Internet Protocol Address (IP) will be assigned by the University at the building location.

35. All Building Automation Systems must provide for remote communications to the Central Operations Office of the Operating Engineer on both the East and West Campuses.

36. All LON wiring must be 22 AWG UTP level 4.

37. All BACnet wiring must be shielded 18 AWG level 4.

38. Acceptable Control Contractors:

- a. Tridium

- b. Alerton Technologies
- c. Distech
- d. KMC

39. Systems Description:

- a. Control system shall be direct digital control (DDC).
- b. Control to be based on BAS architecture consisting of communication network, user workstations, modular designed DDCPs with all points addressable and modifiable from user workstations or from master DDCP user interface panels. BAS shall be fully stand-alone and shall communicate via BACnet/Ethernet/Internet communications protocol. System components shall be fully BACnet/Ethernet/Internet compliant without the use of gateways. System must be able to communicate with the main platform at the University of Illinois at Chicago via Internet Protocol (IP) Address, assigned by the University at the building location.
- c. System shall support user workstations as specified and shall be capable of additional workstations, limited only by systems maximum node capacity.
- d. System intelligence shall be such that user workstation(s) can be used for programming controls, performing analysis on filed data, perform trending of user defined inputs, generating maintenance and operation reports, providing permanent storage for programs and data, and the ability to connect to the Internet.
- e. Safety devices shall function in both auto and hand modes on starter.

40. Recommended instrument and control conductor color code shall be as follows:

Type	Color
120 VAC control signal	Red
120 VAC instrument line power	Black
120 VAC instrument line neutral	White
24 VAC control signal	Yellow
24 VAC instrument line power	Brown
24 VAC instrument line neutral	Orange
Grounds	Green
24 + VDC instrument signal	Black
24 - VDC instrument signal	White or clear
RTD V+	Black

RTD V-	White
RTD compensation	Red

41. Electric signal cables from electronic transmitters to receivers and from controllers to final control elements shall be continuously shielded. Shields shall be grounded at power source end only and floated at the other end.
42. BAS Network Communication Cable:
- a. BAS network communication cable shall not be spliced.

25 11 00- INTEGRATED AUTOMATION NETWORK DEVICES

1. All newly installed BACnet devices shall be installed on two non-firewalled network segments, one for each campus, reserved solely for these devices. No NAT firewalls are to be used on this network. Additional network segments may be added in the future as needed.
2. Integrating devices from multiple vendors requires careful administration of various configuration and management data. Critical vendor device configuration information includes:
 - a. IP number
 - i. IP delegation, routing and switch management are maintained by the Academic Computing and Communications Center (ACCC). IP numbers shall be assigned and registered in the UIC DNS by a REACH representative (currently Bob Deja, as of 03/10/2008.)
 - b. Device Instance number
 - i. Device instance numbers are BACnet native identifiers. Instance numbers must be confirmed with the Physical Plant REACH representative prior to device installation and must be registered in the UIC BACnet database upon registration of the IP number used for said device. UIC Instance numbers shall conform to the following format:

XXXYYYY

where: XXX = UIC building number

YYYY = unique numeric identifier within the designated building.

The resulting numeric string constitutes a campus-wide unique identifier, in order to prevent network device conflicts.
 - c. Virtual Network Number

- i. Virtual network numbers are BACnet designators which segregate BACnet traffic between different vendor devices. Virtual network numbers must be confirmed with the Physical Plant REACH representative prior to device installation and must be registered in the UIC BACnet database upon registration of the IP number used for said device. Each vendor will have sole use of delegated numbers, to prevent network segment conflicts.
- d. UIC BACnet Database Storage
 - i. The UIC BACnet database tables store all necessary information critical to the administration of network configuration and management data. ACCC shall maintain these tables and provide a web-based interface to insert, update, and retrieve all BACnet data. All IP numbers used must be registered in the UIC DNS as well as the UIC BACnet database tables. Table information includes:
 - 1. IP number
 - 2. Device Instance number
 - 3. Virtual Network number
 - 4. Vendor name
 - 5. Device type (Server, BBMD, OWS, etc.)
 - 6. Building number
 - 7. Room number
 - 8. update id (auto-generated netid of person who updated field)
 - 9. timestamp (auto-generated upon database insertion/update)

25 13 00 INTEGRATED AUTOMATION CONTROL AND MONITORING NETWORKS

- 1. Direct Digital Control Panels (DDCP's) shall be microprocessor based, field programmable controllers, capable of performing control and energy management functions, and shall be UL listed as Signaling Systems. Each DDCP shall include its own microprocessor, power supply, input/output modules, and termination modules as required to perform its intended function.
- 2. DDCP shall receive discrete electrical or analog electronic field input signals, convert signals for use by controller, perform control sequences, convert controller information into output signals, and provide control output signals to actuators and field control

device. All inputs and outputs, including communication connections, shall be electrically or optically isolated from controller.

3. DDCP with analog input modules shall be capable of accepting any form of linear or non-linear voltage (0-5 VDC or 0-10 VDC), current (4-20 mA) or resistive input (0-1000 ohm).
4. DDCP with discrete input modules shall be capable of accepting discrete inputs from any device with isolated, dry-type contacts (no grounds or no voltage) of either normally open (NO) or normally closed (NC) configuration.
5. Input modules shall be capable of interfacing with pulsed output type sensors.
6. DDCP shall have capability to scale, offset, and display proper analog value without field hardware modification. DDCP shall convert analog input signals to digital values (A/D conversion) and convert digital values to analog outputs (D/A conversion) for modulating control purposes.
7. Failsafe operation shall be provided such that BAS failures result in immediate return to local control. If the DDCP uses database values from other DDCP and the communication network fails or malfunctions, control loop outputs shall continue to function using last value received from BAS.
8. DDCP shall have ability to interface and communicate with Host Control Panel (HCP) through a dedicated network. DDCP shall be fully operable from and have all points and functions available to centrally alarm at any DDCP or PC workstation connected to a BAS network.
9. Three types of DDCP's are allowed, Building Control Units (BCU's), Remote Control Units (RCU's), and Application Specific Controllers (ASC's).
10. BCU's are defined as having capabilities of direct connection to high speed Local Area Network (LAN) (greater than 500 kilobaud), serve as communications hub for other BCU's on slower speed LAN, and have sufficient processor capabilities and RAM to implement all types of custom software applications. BCU's shall have serial type input/output (I/O) ports to directly support operator workstations (portable PCs), standard ASCII dumb terminals, modems, and all types of printers.
11. BCU's shall have uninterrupted real time clocks capable of time of day, week, and year information to the system as needed to perform software functions. Clock shall be programmed to reset twice a year to allow for Daylight Savings Time. Clocks in multiple BCU's shall be synchronized automatically to match designated BCU or workstation. Accuracy shall be within 1 second per day minimum.

12. BCU batteries shall maintain all volatile memory and real time clocks for a period of at least 72 hours during power failure. Batteries shall be maintenance free and have minimum life of 2 years. When power has been restored, the following shall occur automatically:
 - a. Orderly startup of all controlled equipment (user defined).
 - b. Continuation of all control algorithms.
 - c. Data base revision.
 - d. Log times of power interruption and restoration.
 - e. Battery recharging.
13. RCU's are defined as being the same as BCU's but without high-speed LAN capabilities or I/O ports. RCU's shall communicate with BCU's and other RCU's via low/medium speed network or direct serial or parallel data bus interface.
14. ASC's are defined as having standard software burned into EPROM, set points in EEPROM or RAM maintained by battery, and are designed to handle specific types of control sequences. ASC's shall be capable of communicating to BAS network via low/medium speed network connected to BCU's.
15. All software and hardware to be covered by site license for a minimum of 30 users. Adding to or modification of the basic system should not require additional licenses.
16. BCU/RCU Software shall contain:
 - a. Program modules for performing energy management control functions such as time of day change of database values (programmed start/stop, temperature setbacks, etc.), supply air temperature reset based on space load demand, economizer control, optimum start/stop based on current indoor and outdoor psychometrics, duty cycling and client tailored programs required for special applications such as VAV fan matching and supply fan control, enthalpy control, intermediate season or "dead band" control, totalizing, and holiday programming.
 - b. Manufacturer's standard operating system for real time control of system interactions, including database information requests/transfers by system hardware or by operators. Operating system shall also have the following additional capabilities (given operator has appropriate security access level):
 - i. Display any database (point) value including measured values, controlled variables, set points, gain factors, and any other adjustable parameter.
 - ii. Change or override any database value.

- iii. Error detection, correction, re-transmission of database values, arithmetic or logical faults.
- iv. Alarm reporting including sending alarms to remote workstations on network or by modem.
- v. Alarm buffer to retain all alarms in order of importance without losing any alarms.
- vi. Creating and displaying historical trend logging any value limited only by available memory.
- vii. Create new variable database values (soft points) based on arithmetic calculation (including summation or totalizing) on other database values.
- viii. Add new hardware points without overall BAS shutdown.

17. All hardware/software to update database in less than 1 second for fast-acting control loops such as pressure control, air or water volume control, and air handling unit temperature control, or 10 seconds or less for all other control loops.

18. Graphics to be generated shall include, but not be limited to:

- a. Site Plans, including each building, building name, and status of all exterior points such as lighting, etc.
- b. Overall building plan of each building. Indicate location of mechanical rooms and areas served by each air handling unit.
- c. Voltage and current values shall be displayed for all motors 50 HP and above. Each shall be displayed next to the motor graphic on the display screens.
- d. Schematic type graphics for:
 - i. Each air handling system
 - ii. Supply fan control loop
 - iii. Cooling coil control loop
 - iv. Heating coil control loop
 - v. Humidifier control loop
 - vi. Damper control loops
 - vii. Steam system showing all components
 - viii. Each hot water system showing all components.

**25 30 00-INTEGRATED AUTOMATION INSTRUMENTATION
AND TERMINAL DEVICES**

- 1. Accuracy of devices shall be $\pm 1\%$ of scale with adjustable offset unless otherwise specified.

2. Wall mounted space thermostat enclosure shall have concealed sensing element and exposed set point adjustment.
3. Unless otherwise stated, space thermostat covers shall be brushed aluminum or brushed nickel.
4. Temperature Low Limit Switches (Freezestats):
 - a. Electric 2 position type with temperature sensing element and manual reset. Controls shall be capable of opening circuit if any one foot length of sensing element is subject to temperature below setting.
 - b. Sensing element shall not be less than one lineal foot per square foot of coil surface areas. Temperature switch set point is 38°F.
 - c. Where multiple switches are required, each switch shall have a separate point names in the BAS. Each alarm in BAS shall indicate which temperature low limit has opened or tripped.
5. Pressure Differential Switches (Air Systems):
 - a. Pressure differential switches for air systems shall have pressure rating of at least 1-1/2 times the systems pressure.
6. Pressure Differential Switches (Water Systems):
 - a. Pressure differential switches for water systems shall be rated for 1-1/2 times system pressure. Chilled water pressure differential switches shall be provided with totally sealed vapor tight switch enclosure. Differential pressure switches to have 3-valve manifold for servicing.
7. Level Switches (Ultrasonic Gap Sensor):
 - a. Radio Frequency (RF) type point level probe with stainless steel probe and DPDT snap action relay contacts to meet intended use. Probe shall have a machined gap in the probe to sense presence or absence of water or other fluid. Probe length shall be determined by application.
8. Analog Electronic Instrumentation: The following shall be standard off-the-shelf, commercially available and applicable for use with electronic control/monitoring systems.
 - a. Space Temperature Sensors
 - b. Duct Mounted, Insertion or outside Temperature Sensors
 - c. Direct Insertion Temperature Sensors
 - d. RTD Temperature Transmitters
 - e. Space Humidity Sensors/Transmitters
 - f. Duct Mounted Humidity Sensors/Transmitters

- g. Ducted Air System Static Pressure and Differential Pressure (Velocity) Transmitters
- h. Pressure/Differential Pressure Transmitter
- i. Vortex Flowmeter/Transmitter (Steam)
- j. Capacitance Type Level Transmitter
- k. Pressure (E-P) Transducers
- l. Carbon Monoxide Monitor

25 35 16 INTEGRATED AUTOMATION SENSORS AND CONTROLS

- 1. Control Instruments
- 2. Thermostat
- 3. Temperature Sensors
- 4. Valves / Actuators
- 5. Dampers / Actuators
- 6. Humidity Sensors
- 7. Control Panels / Transformers and Wiring
- 8. Electronic Building Network Controllers
- 9. Networked Modular I/O and Unitary Controllers
- 10. Local and Remote Browser / Operator Work Station
- 11. Building Site Server / Firewall Description
- 12. Hardware
- 13. BAW/OWS Issues
- 14. Water Flow Meters (Magnetic)
- 15. Differential Pressure Transmitter (Liquid)
- 16. Gas Meter
- 17. Demand Control CO2
- 18. Air Flow Measuring
- 19. Gas Monitoring
- 20. Lighting Control
- 21. Security Control
- 22. Miscellaneous Control Equipment Wiring
- 23. Programming/Graphics
- 24. Programming will combine the simplicity of graphical programming with the precision and efficiency of line-oriented Java script programming. It must deliver a library of math,

logic and control blocks that the programmer can drag and drop onto the screen to graphically model the control strategy for a piece of HVAC equipment. These control strategies must provide excellent sequence documentation and are reusable, eliminating the need to recreate them for every project.

25. NOTE: The BAS system must have:

- a. A built-in web server and Internet interface.
- b. XML formatted data over HTTP.
- c. FOX over IP or ASHRAE BACnet/IP protocol over Ethernet cabling.
- d. Microsoft Windows XP or 2000 Professional Operating Systems compatibility.
- e. IT-friendly connectivity, firewall compatible.

26. All points shall be trendable.

27. The successful bidder shall provide graphs of trend logs of all points specified by the A/E on the point list for every project. It is the intention of the University to have trend logs periodically (i.e., every 15 minutes). The successful bidder shall prove to the university through the trend logs that all devices are working properly and smoothly (i.e., no hunting of valves or dampers will be allowed).

28. There shall be an option for Internet users to edit the frequency of time for the trend log table.

29. There shall be a sub-link which directs to a page where one can overlap the different graphs at one time at the same scale.

30. The BAS contractor will display all dynamic color graphics as required by owner.

- a. All color graphic floor plan (project's CADD/Auto CAD drawings transported) displays and system schematics for each piece of mechanical equipment, including air-handling units, chilled water systems and hot water systems will be provided to optimize the system performance analysis and speed alarm recognition. The sequence of control for each piece of mechanical equipment shown on a graphic must also be included as an overlay on that screen. This will allow the operator to review the sequence of control on the graphical screen pertaining to mechanical equipment shown. All software engineering required to construct the graphics to be included under this contract.
- b. System operator security/penetration: The system operator's security clearance level will allow the user to access the various system schematics and floor plans, based upon the owner's appointed security level given to that user.
- c. Dynamic data displays: Dynamic temperature valves, humidity valves, flow valves and status conditions shall be shown in their actual respective locations and

shall automatically update to represent current conditions without operator intervention.

- d. Graphics' colors pertaining to on/off status will be "green" for on and "red" for off conditions.
- e. Dynamic objects shall include analog and binary values, dynamic text and static text.

31. Basic design considerations for building temperature control include the following:

- a. The use of hydronic heating is preferred.
- b. Direct radiation in rooms should be provided with wall thermostatic control.
- c. Room thermostats shall control all heating and cooling in the room.
- d. A diagram of the temperature control system and a sequence of operations prepared by the Contractor and mounted under glass shall be installed in the mechanical equipment room for each project.
- e. All HVAC air-handling units must be provided with a manually adjustable freezestats.
- f. Winter-summer changeover switches and damper control switches must have manual override provisions incorporated in the temperature control systems.
- g. Provide a high limit humidistat in systems with humidifiers.
- h. When cooling is introduced in the system, it is preferred (if reciprocating type compressors are used) that the compressor operates on suction pressure control to give approximately constant suction temperature, and a relatively constant apparatus dew point. A solenoid valve in the liquid line at the expansion valve, operated by room or return air humidistat can be used, and together with the reheat coils and controls maintain predetermined room temperature and humidity.

32. Automatic Dampers

- a. Each damper section shall have an individual operator. No linkages shall be installed between dampers to transfer operator power. Manufacturer's catalog information shall be de-rated 50% for application to provide positioning of the dampers. Damper operators shall not be of the swing mounting type. They should be mounted outside the air stream where possible, especially in outside air applications. Pneumatic control lines, where they penetrate outside air ducts, shall include dehydrator units. Outside air and return or relief dampers that are automatically controlled shall be of the minimum leakage type. Quality of dampers shall be specified, including air leakage at 3/4 inch static pressure

when the damper is in the closed position. Provide neoprene edges and tips on blades.

33. Electronic Control valves and Dampers

- a. All control valves and dampers shall be electronic modulating.
- b. They shall all be "proportional" and shall provide feedback to the BAS.

25 36 13 INTEGRATED AUTOMATION POWER METERS

1. All new buildings constructed at UIC shall have a new networked utility (BTU) metering system installed and integrated with the campus Energy Management System as owned and maintained by the Utilities department. All projects at UIC that involve HVAC renovations or improvements with a projected budget of over \$125,000 shall consult with the Director of Utilities about the possible need for new networked metering in that building.
2. BTU metering system shall consist of: flow metering heads and temperature sensors for Chilled Water and High Temperature Hot Water service from the plant, and steam volume metering heads, temperature and pressure sensors along with condensate return volume where used. Metering heads and all pressure and temperature sensors shall be directly connected to a local Btu meter. Installation of all metering components shall fully comply with that component manufacturer's recommended installation practices, especially where lengths of straight pipe and component fastening are concerned.
3. BTU meter shall include these features at a minimum:
 - a. Input resolution of .0015% of full scale, 16 bit A/D. Input impedance > 1 Mohm.
 - b. A measurement rate of 10x per second on all inputs.
 - c. All inputs shall be configurable to read any combination of 4-20mA, J K T E N S B Thermocouples, and RTDs. RTDs shall have a base accuracy of 0.2% or 0.5 °C (1 °F) and resolution of 0.1 °C.
 - d. User programmable recording rates, starting at 10 samples per second.
 - e. Ability to store all data at the meter in NVRAM collected from 12 channels over a 7 day period at 1 sample per second.
 - f. Built-in Ethernet port that allows all data to be sent to the Utilities Energy Management System via MODbus/TCP or BACnet/TCP protocols.

- g. Built-in local screen with the ability to show live or archived data from any input channel.
 - h. All meter features shall be fully programmable via the built-in screen and buttons on the meter. No external software shall be needed to set up or program any meter features.
 - i. Meters shall operate accurately in environments from 0 °C to 50 °C, 10% to 80% RH (non-condensing).
 - j. BTU meters shall be UL rated and meet requirements of EN61010-1.
 - k. BTU meter shall communicate to flow metering heads via 4-20mA loop or MODbus protocol over RS485.
4. Flow metering heads for Chilled Water (CHW) shall be ABB WaterMaster electromagnetic flow meters or Flexim Ultrasonic flowmeters (or 100% equivalent).
- a. Meters shall meet or exceed OIML R49-1 standard.
 - b. Meter housing shall meet NEMA 4X or IP 65 at a minimum.
 - c. Meters shall operate accurately in environments from -20 °C to 70 °C, 0% to 100% RH.
 - d. Meter shall output its signal via 4-20mA loop or MODbus protocol over RS485.
5. Flow metering heads for High Temperature Hot Water (HTHW) shall be Flexim Ultrasonic flowmeters (or 100% equivalent).
- a. Flow meter shall be capable of achieving accuracy within +/- 0.5% of the flow reading +/- 0.1 m/s with a field calibration.
 - b. Meter housing shall meet NEMA 4X or IP 65 at a minimum.
 - c. Repeatability shall be 0.15% of reading +/- 0.1 m/s.
 - d. Response time shall be 1 second or less; the measuring cycle shall be adjustable from 100 to 1000 Hz.
6. Flow metering heads for Steam measurements shall be Sierra Instruments series 240 ultrasonic (or 100% equivalent).
- a. Mass Flowrate shall be accurate to +/- 1.5% over a 30:1 range from 50 to 100% of the pressure transducer's full scale.
 - b. Volumetric flow rate shall be accurate to +/- 1% of rate over a 30:1 range.
 - c. Temperature accuracy shall be +/- 1 °C.
 - d. Pressure shall be accurate to 0.4% of transducer full scale.
 - e. Density shall be accurate to 0.5% of reading from 50 to 100% of transducer's full scale.
 - f. Response time shall be adjustable from 1 to 100 seconds.

- g. Meter shall have an alphanumeric display and feature a NEMA 4X explosion-proof housing.
 - h. Meter shall feature 4-20mA for output signals; no pulse outputs are allowed.
 - i. Meter shall be capable of accurate operation in an environment ranging from -5°F to 140° F; 0-98% RH (non-condensing).
7. All temperature sensors used in metering shall consist of a balanced matched pair per application; sensors shall have an NIST traceable accuracy.
 8. In installations where both the CHW and HTHW metering heads are to be provided by FLEXIM, then a FLEXIM BTU meter shall also be used.
 9. There are three electrical meter manufacturers and models allowed at UIC. It shall be the responsibility of the installing contractor to insure that the meter chosen and the associated current transformers is correct for the power levels being monitored.
 10. The three acceptable meters are:
 - a. Honeywell DIN-MON meter series D5 with MODbus/Ethernet communication
Electro Industries Shark 200 V2 series with MODbus/Ethernet communication
SquareD PM820 meter with the PM8ECC communication card using MODbus/Ethernet
 - b. Each meter shall communicate with and send data to the existing campus MAIN TRIDIUM server using MODbus protocol. Trend / History polling intervals shall be set up for 15 minutes. Failure to use a 15 minute interval skews the data. Real Voltage, Current, Demand and Consumption data shall be provided at a minimum. All meters shall have a built-in display.
 - i. Manufacturer site start-up shall be provided along with meter. Electrical meter provider shall fully commission each device and provide a report to the Director of Utilities at UIC confirming meter accuracy as installed. Manufacturer factory calibration certification shall not be used as a substitute for this report.
 - ii. In new construction, a meter shall be provided and installed for each of these: Total building power, HVAC / MCC power used, Lighting power used, and general building power used (i.e., outlets).
 - iii. Meter shall come in a NEMA 12/13 housing.

25 55 00 INTEGRATED AUTOMATION CONTROL OF HVAC

1. Provide a Sequence of Operations for new building Systems as approved by the User.
2. Provide Central HVAC Systems Display as applicable:

- a. System graphic
- b. System on/off indication
- c. System day/night mode
- d. Supply fan on/off indication
- e. Return fan on/off indication
- f. Heating coil pump on/off indication
- g. Outside air temperature indication
- h. Mixed air temperature indication
- i. Fan discharge air temperature indication
- j. Fan discharge temperature control point adjustment
- k. Supply static pressure indication
- l. Supply static pressure control point adjustment
- m. Humidity sensor
- n. Enthalpy sensor
- o. System on/off auto switch position.
- p. System day/night/auto switch position
- q. Supply fan on/off switch position.
- r. Return fan on/off/auto switch position. 1
- s. Heating coil pump on/off switch position.

**This section of the Building Standards establishes minimum requirements only.
It should not be used as a complete specification**