Building Automation Systems: A large percentage of the HVAC systems within campus buildings are served by direct digital control (DDC) building automation systems (BAS) with remote monitoring and control capability. Each system communicates with the central control station located within the Physical Plant Service Building (PPSB) through the campus Ethernet data communications system. At the control station each manufacturer's control system(s) has a dedicated “host” computer or “head end” unit. The capabilities of each host computer include the following: monitoring, alarming/paging, trending, password management, programming of stand-alone controllers as well as storage of the configuration/programming of each stand-alone controller. In addition to these DDC systems a primitive legacy system also exists on campus. It is a proprietary system developed for the U of I in the early 1980’s, and is referred to as “MACS”. It is limited in its capabilities to monitoring and start-stop control of equipment. The MACS system was propagated over many years and is still heavily relied upon to serve numerous existing applications. This system is being incrementally phased out of service as opportunity allows.

BAS Integration: Integration of the BAS for HVAC systems with other building automation systems such as fire alarm, card access, security, lighting, refrigerant detection and elevator systems is allowed, but only to a limited degree. Systems shall have independent control panels and communication networks. They may, in some cases, share devices. For example, an occupancy sensor may be shared between the BAS for HVAC and the lighting control system. For the most part, integration shall be limited to monitoring. Each alarm from fire alarm BAS, refrigerant detection BAS, etc. shall be a hardwired digital input to the appropriate stand-alone digital controller (SDC). This type of integration shall be provided only when needed for control of the associated unit(s) during an alarm condition, such as shut down or smoke control operating mode in response to a fire alarm, ventilation mode in response to a refrigerant alarm, etc.

System Architecture: Each DDC building automation system for HVAC shall be a network of independent stand-alone digital controllers (SDC’s). Each SDC shall be capable of full control either as a completely independent unit or as a part of a building-wide control system. Each SDC shall be capable of communicating with each other without the use of a central host computer within the building level network. Each SDC shall directly communicate to a building Network Interface Module (NIM) which shall be connected to the campus Ethernet. Each SDC shall be provided with two CITES Ethernet connections, one for the controller (native Ethernet protocol) and the other for a portable laptop computer. They shall follow the U of I CITES coordination procedure submitted in this general overview and in Section 23 09 23 – Building Automation System (BAS) for HVAC. The NIM shall communicate with the central host computer and other NIMs on the system via an Ethernet connection. Each DDC system shall accommodate internet enabled viewing of the control system. All building level network controllers shall be native Ethernet peer to peer architecture. Floor level network devices shall be provided with manufacturer's native protocol: Siemens Apogee P2, Andover Infinity / Continuum, Invensys BACnet.

Programming: A single control programming language shall be used for each manufacturer’s system and shall be fully programmable from the central host computer, which shall also function as the database server. The system shall utilize client/server architecture, with all points and program databases stored on the server central host computer. All operator workstations shall serve as clients.

Graphics: Each DDC system shall monitor and control equipment as indicated in the Sequence of Operation and points list. A graphical representation of each system shall be made available at all operator work stations. Each system “graphic” shall display all control and monitoring points and alarms. A security hierarchy shall be provided. It shall limit modifications to the sequence of operation or programming to a select number of personnel at a high security level. User adjustable set points shall be
available for change by trained personnel at appropriate security levels.

**Licensing:** Where required by the system architecture, the vendor shall provide a client license for utilization at the project site. An additional client license along with programming and engineering tools for the installed systems shall be provided to the Facilities and Services Division.

**Approved Manufacturers:** Currently, new installations of DDC building automation systems for HVAC are limited to the following three approved manufacturers/systems:

1. Siemens "Apogee"  
2. Schneider Electric Building Systems "I/A Series"  
3. Andover "Infinity/Continuum"

**LEED Requirements:** Each LEED project shall meet the requirements of the U.S. Green Building Council Leadership in Energy and Environmental Design (LEED) program. Each new project will attempt to achieve the U.S. Green Building Council’s LEED Version 2.2 Certification level. The AE shall carefully examine the controls LEED portion, and will attempt to achieve the following LEED points at a minimum:

**Energy and Atmosphere:**  
Prerequisite 1 – “Fundamental Building Systems Commissioning”  
Prerequisite 2 – “Minimum Energy Performance”  
Credit 3 – “Additional Commissioning”  
Credit 5 – "Measurement and Verification"

**Indoor Environmental Quality:**  
Prerequisite 1 – “Minimum IAQ Performance”  
Credit 1 – “Outdoor Air Delivery Monitoring”  
Credit 2 – “Increased Ventilation”  
Credit 6 – “Controllability of Systems”  
Credit 6.1 – “Lighting Control”  
Credit 6.2 – “Thermal Comfort”

**Applications:** At a minimum the following equipment and systems shall be fitted with DDC and shall be integrated into the BAS.

1. Central Station Equipment: Includes air handling units and associated return/relief fans, chillers, chilled water pumps, cooling towers, condenser water pumps, chilled water BTU metering stations, boilers, heat exchangers, hot water pumps, hydronic filtering stations, steam condensate return units, sewage ejectors, sump pumps and domestic water booster stations.
2. Exhaust Fans: Includes toilet exhaust, general exhaust, laboratory exhaust and equipment room ventilation fans.
3. Terminal Units: Includes VAV boxes, reheat coils, and perimeter heating units.
4. Room Pressurization Controls (i.e. dynamic monitoring and control of relative room pressurization)
5. Hydronic System DP & SP Control (i.e. control of pump speed and monitoring of system fill pressure)
6. Metering Equipment: Includes meters for domestic water, natural gas, steam condensate and chilled water (as well as steam and compressed air where applicable). Electric metering (kWh), however, shall not utilize a BAS. It shall be designed and installed separately. Modbus TCP protocol shall be used.
7. Utility Service Entrance Devices (e.g. steam, chilled water): Includes temperature and pressure sensors as well as pressure and flow control valves.

**Installation:** DDC controllers and auxiliary panels shall be installed on free-standing support racks as detailed within the Technical Sections and Drawings within these Facilities Standards. Installation of field devices, conduit, wiring and pneumatic tubing shall be as indicated within the Technical Sections within these Facilities Standards.

**Emergency Power:** BAS controllers and system components shall be powered from external emergency power sources (via emergency panels).

**Dedicated Circuits:** BAS controllers and system components shall be fed from dedicated circuits that do not serve non-BAS equipment or devices.

**Non-BAS Control Circuits:** Any non-DDC/BAS control circuit associated with a piece of equipment shall be no greater than 120 V. It shall be configured such that it is active only when the equipment it serves is active. Therefore an independent circuit
shall not be used to power a non-DDC control circuit.

**Safety Control Devices:** Each safety control device, such as a freeze protection thermostat, a high or low pressure safety switch or a cooling tower vibration switch, shall be hard-wired into the safety circuit (typically of the motor starter or VFD) that serves the associated piece of equipment. In addition, it may also be wired into the BAS for the purpose of generating an alarm. Safety devices shall be installed and wired such that system safeties remain functional even when the BAS is non-functional.

**Pneumatic Controls:** Although the control industry continues to move away from the use of pneumatic controls, pneumatic actuators are still viewed by the University to be superior to electric actuators for high torque applications. Pneumatic actuators are recommended by the University to be used for steam service, especially in existing buildings where a 20 PSI compressed air source is readily available. Thus, their use is encouraged for such applications.

**Compressed Air Source:** A dedicated control air compressor unit shall be installed to serve pneumatic controls in each building unless a source of operational campus-wide central compressed air is available. Each air compressor unit shall be a duplex unit sized to maintain adequate control air capacity with neither compressor running more than 33% of the time. Air filters, air dryer and other specialties shall be provided at each compressor unit installation.

**Control Valves:** The University is endeavoring, in conjunction with the current trend in the valve industry, to move from the use of sliding stem globe type control valves to the use of rotary valves for HVAC applications. The U of I has standardized on the use of HVAC grade rotary valves for most hydronic applications and the use of industrial grade valves for a limited number of applications where HVAC grade valves are deemed inappropriate or inadequate. Also, the University is researching the use of pressure independent control valves in hydronic systems. For more detailed information in regard to control valves, see Sections 23 09 13.33 - Control Valves and 23 09 13.34 - Control Valve Actuators within these Standards.

**Instrumentation and Control Devices for HVAC:** The University is endeavoring, in conjunction with the current trend in the HVAC industry, to use instrumentation with distributed direct digital control (DDC) capability and with electric/electronic actuation on most of the new control devices. For more details, see Section 23 09 13 - Instrumentation and Control Devices for HVAC within these Standards.

**Variable Frequency Drives (VFD):** The University is endeavoring, in conjunction with the current trend in the HVAC industry, to use Variable Frequency Drives to conserve energy. Typical applications include motors for pumps, air handling unit fans, and chillers, etc. Typically, the VFD specification is listed in Division 26 - Electrical. However, VFD information will have to be referenced in the controls section for any necessary controls work and auxiliary instrumentation, such as Isoverters (signal convertors). For more details, see Sections 23 09 13 - Instrumentation and Control Devices for HVAC and 26 29 23 - Variable Frequency Motor Controllers.

**Coordination with U of I CITES Plant Engineering:** Early in the design phase of the project, the AE shall contact the U of I CITES Plant Engineering at (217) 244-1600 for assistance in locating the CER – Communication Equipment Room and associated conduit/cable routing. The AE shall show approximate control panel location on the general equipment plan view drawings. Construction Documents shall include the CITES coordination information stated in Section 23 09 23 – Building Automation System (BAS) for HVAC.

**AE Submittals:** The AE shall submit complete Auto CAD drawings and PDF files of controls schematic of the new control systems during the design process and in the Construction Documents. The documents shall include general equipment layout with control panel locations in mechanical rooms and CER room locations. AE submittals shall include a complete description of the operation of the control systems, including sequence of operation. AE submittals shall include a complete point...
list of all points to be connected to the TCS (Temperature Control System) and FMCS (Facility Management Control System). The point list for each system shall include both inputs and outputs (I/O), point numbers, point description, purpose and type (analog vs. binary) of the controlled device associated with the I/O point, the location of the I/O device, and reference drawing. The preliminary point list shall be provided at the 50% submittal, in addition to a point list at the 95% and bid set submittal. The point list shall be provided diagrammatically as part of the control schematic or in a spreadsheet format. For purpose of coordination throughout design, all I/O points including virtual points, shall be presumed to be trended with the intent of being required in the bid set. The AE submittals shall include the damper schedule and valve schedule. These schedules shall include Minimum and Maximum flow values, and inlet & outlet pressure conditions necessary for accurate sizing of the control valves and other devices.

**Control System Naming Convention**: The University has developed a standard naming convention for equipment identification and BAS programming. Coordinate with the F&S Systems and Controls Group early in design development to ensure identification of new and replacement equipment is consistent with this standard naming convention.

**General**: AE shall be prudent in the use of the term “capable of” in their documents and on drawings. AE shall fully understand that Controls providers will not provide the necessary programming when only required to provide capability. AE designers shall require the relevant hard-wired and virtual control points and programming code.