DIVISION 25 – INTEGRATED AUTOMATION
25 50 00 INTEGRATED AUTOMATION FACILITY CONTROLS

PART 1 - GENERAL

1.01 GENERAL

A. Washington State University operates and maintains a state-of-the-art Building Automation System (BAS). The WSU BAS utilizes the Siemens Building Technologies Apogee system and the Alerton Ascent Building Management System. The BAS is capable of, but not limited to, global campus controlling of electrical demand, heating demand and cooling demand using duty cycling, chiller optimization, peak demand limiting and start stop time optimization programs, lighting controls, irrigation, security, domestic water wells and reservoirs, metering condensate, metering chilled water, metering domestic water, metering electricity, and other applications. The control is provided via Ethernet connections. The field panels report analog and digital value changes to the BAS server for alarm management and trending. The field panels are programmed to be fully-stand alone and power recoverable after electrical failures or loss of communication with the BAS server.

B. Building Automation Systems (BAS) Design Criteria:

1. Communications: The WSU BAS is a physically and logically separate series of networks and security protocols that operate in a closed system. Therefore, no ingress or egress routes are available for use in any communications. All communications with centralized systems such as Siemens or Alerton applications shall be connected to and configured to operate within the private network space.

2. Telecommunications Infrastructure: Because the WSU BAS is a closed system, several design standards are critical to maintain its overall health and security:

   i. BAS Switches and UPSs: All switches and UPS devices used in the BAS will be specified, procured and installed by WSU Finance and Administration Information Systems (FAIS). Not all projects will require BAS infrastructure, as it may already exist. Contact FAIS through the WSU Project Manager to identify the closest BAS annexation point.

   ii. Rack Space: In order to accommodate building automation networks and associated equipment, the BAS will need at least 8 rack units of space per Telecomm Closet and 10 rack units per MCF. This specification will accommodate all BAS switches, UPS, and surveillance servers.

iii. Power: WSU BAS will require at least four (4) 120v power outlets in each Telecomm Closet and in each MCF to accommodate power for BAS network components.

iv. Gigabit Passive Optical Network (GPON): No GPON equipment shall be used as part of the BAS infrastructure, and BAS devices shall not be connected to Optical Line Terminal (OLT) devices. Since GPON buildings contain significant fiber cable plans, allocating fiber per the BAS standard will allow for proper configuration and deployment.

v. Fiber Optic: WSU BAS networks require 4 strands of single mode fiber feeding each new building or remodeled building and 4 strands of single mode fiber between each MCF and Telecomm Closet. This will accommodate a redundant pair of network uplinks for critical network components. All fiber media shall be 62.5 microns.

1) If single mode fiber is not available in the building's distribution media, then this standard can be applied to multi-mode media instead.

3. Digital Direct Control: Control system shall be Digital Direct Control (DDC) to control building HVAC systems, pumps, converters, chillers, cooling towers, room VAV systems, VAV fume hood systems and other support systems on and off campus.

4. Individual Room Controls: Individual room controls are required in all office, classrooms, laboratories and other occupied areas.

5. System Controls: All BAS shall be electronic with electronic final control elements. Renovations/modifications requiring compressed air shall have a pneumatic module controlled by a BAS electronic signal converting electric to pneumatic.

6. Provide 10-minute Uninterruptable Power Supply (UPS) for each BAS panel (see Section 26 33 53 "Static Uninterruptable Power Supply").

i. Pre-Approved Manufacturer/Model: Functional Devices PSC100

C. This system utilizes single point, campus global controlling (this ability shall be maintained) to directly manage the following systems as a minimum:

1. Staggered power recovery after outages.

2. Heating demand for limiting purposes during emergency conditions.

3. Cooling demand for chilled water tank storage management.

4. Campus chilled water loop pumping function at multiple locations.

5. Central Chiller Plant operation.

6. Operation / integration of campus chillers into the chilled water loop.

7. Snowmelt system for outside stairways and walkways of campus.

8. Ice-melt systems for gutters, downspouts and pipe protection.

9. Domestic water wells and reservoirs.

D. To ensure a fully functional system, the Consulting Engineer shall specify end devices and equipment that are capable of interfacing with the Siemens or Alerton BAS to provide the points listed below.

E. The following is a listing of typical points to be controlled or monitored by BAS. This list is not intended to be all-inclusive, and shall be customized to meet the project sequence of operations.

1. HVAC Systems:

   i. AHU: fan; stop/start/proof; reclaim air; outside air; heating and cooling discharge air; mixed air; supply air; return air; coil pump stop/start/proof; heating and cooling coil valve modulation; duct and building static pressure monitoring; static pressure control; low temperature detection; supply duct humidity; and ventilation.

   ii. Converter: inlet and outlet temp; pump start/stop/proof and alternation or speed control.

   iii. Cooling tower: inlet and outlet temp; dampers or VFD control; pump start/stop/proof.

   iv. Chilled Water: building inlet and outlet temp, flow and decoupling operation; room temperature by fan system; process cooling system inlet and outlet temp and pump start/stop/proof.

   v. Terminal reheat valve; Terminal ventilation control; Terminal discharge air temperature sensor.

   vi. Laboratories fume hoods and room pressurization.

   vii. Process Cooling systems.

2. Alarm Systems:

   i. Filter banks; clean room pressure, temperature and humidity; condensate pump operation & high levels; sump pump high level alarm; compressed air system low press; fire alarm zone alarm and trouble indicator; elevator trouble and elevator machine room temperature.

ii. Computer room A/C units: filters; high and low temperature and humidity.

iii. Research chambers and museum storage.

3. Building Systems:

i. Snow melt heat exchangers

ii. De-icing cable

iii. Steam metering, pressure and conductivity monitoring

iv. Chilled water flow

v. Spa and saunas

vi. CO and CO_2 building and parking monitors

vii. NO_2 monitors required in enclosed areas known to operate diesel vehicles

viii. Research chambers

ix. Domestic wells and reservoirs

4. BAS shall be able to reset the following Operations:

i. Facilities Scheduling

F. Sequence of Operation (TYPICAL APPLICATION)

1. Air Handling Units:

i. The BAS signals the starting sequence with a normally open maintained contact closure.

ii. Upon a start signal, in a mixed air system, the outside air and exhaust air dampers shall remain closed and the return air dampers shall remain open and will slowly ramp into operation over a six (6) minute period allowing a controlled ease-in of operation. A reset schedule for the mixed air control loop will be based on the return or exhaust air temperature for its associated air handler unit. Keeping in mind the warmest space needs need to be satisfied. A typical reset schedule is RA 72 dg F MA 58 dg F and RA 68 dg F MA 66dg F.

iii. The supply fan speed operates from duct static pressure control or a fan plenum static pressure high limit. The duct static pressure set point shall be established by the TAB and shall be the lowest pressure required to do the job. The duct pressure transmitter will be located at two-thirds of the duct distance from the air handler common to an area requiring the most volume of air to satisfy air delivery. A supply air flow sensor station shall signal the BAS to the modulate fan speed controller to maintain the correct airflow.

iv. A temperature sensor in the discharge of the air stream of each coil unit shall signal the BAS to modulate the preheat coil and chilled water coil valves in order to maintain the correct discharge temperature set points. The preheat set point is set for the lowest temp required i.e. 55 dg F. The pre-heat coil (assumes Wing Type coil) face and bypass shall modulate open the steam valve and then the bypass damper in order to fully load the coil tubes and prevent stratification of the air stream. The mixed air set point varies on a return air table in heating mode and economizer to min OSA inlet when the OSA is above 76 dg F and the OSA-RA temp is greater than 2 dg F. The cooling set point is on a return air table i.e. typical RA 80 CL 60 – RA 74 CL 65 dg F. In Full or substantial OSA units the reclaim recovery will lead the mixed air set point by 2 dg F. Proper alarm values will be set in coordination with the WSU Controls Shop.

v. Low limit manual reset protecting thermostats wired in series in the start string shall stop the fan, should preheat cold discharge temperature decrease below 37 degrees F. (or as set). A secondary contact shall show the status of the low limit thermostat and will alarm the abnormal condition.

vi. Duct mounted ionization type smoke detectors shall stop the fan should products of combustion be detected. The Division 26 00 00 Electrical Contractor responsible for the fire alarms system shall provide and install the necessary duct smoke detectors with auxiliary contacts for connection within 3 feet of fan motor.

2. Heating Converter - Steam to Hot Water:

i. An immersion temperature sensor with well in the HWS line shall signal the BAS to modulate (typically) the 1/3, 2/3 valve arrangements in order to maintain a reset schedule based on Outside Air Temperature.

3. VAV Terminal Boxes and Fin Tube Heaters:

i. Utilizing direct digital control, room sensors shall control VAV boxes and fin tube radiators in sequence. On a call for cooling, the box damper shall modulate open. Both the radiator and reheat coil valves shall be closed. On call for heating, the VAV box damper modulates closed to minimum position. The VAV reheat valve and fin tube shall then begin to modulate open. Occupied / unoccupied logic will be applied.

4. Toilet and Other Exhaust Fans:

   i. Exhaust fans serving toilet areas shall be start/stop/proofed and scheduled by time of day scheduling through the BAS. Start/Stop time schedule shall be provided to Contractor by the University and will be adjustable from the WSU Control Shop.

5. Computer Room HVAC Units:

   i. BAS shall monitor and enable control packaged Computer room units; alarm and report & record any alarm/failures to WSU Facilities Services Operations Center for response.

6. 100 Percent Outside Air HVAC Systems:

   i. Dampers shall be provided with an end switch on the damper blades to shut down the fan if the outside air dampers close for any reason. Adjustment of the end switch will allow the dampers to be open 50 percent before fan shall startup.

7. Domestic and Laboratory Hot Water Heater:

   i. The instantaneous water heaters shall be DDC controlled and the control valve shall be sized and supplied by the BAS contractor.

   ii. The re-circulation pump(s) will be operated and scheduled from the BAS and will have the schedule provided to the BAS contractor by the University.

8. Electric Snowmelt and Gutter Heaters:

   i. Gutter heaters will be turned on by OSA temperature and will be managed for staggered restart after a power outage.

   ii. Snowmelt for exterior stairs and walkways shall be single point controlled through the Operations Center. These units will duty cycle throughout their operation for conservation and peak shedding. They will be stagger started on a power outage recovery.

9. Laboratory Fume Hoods:

    i. Fume hood will incorporate VAV function and will be of DDC control type. Measuring the open area via sash position will control the fume hood volume and then setting the air volume to the value required to maintain 100 FPM, the action time will be less than 3 seconds.

    ii. The Fume hood controller will incorporate an alarm that will indicate low / high velocity alarms and will display the airflow in feet per minute. The alarm will be a locally audible indicated alarm, with a local silence, and report alarm condition to the BAS Operations center.

    iii. The makeup air requirements will be controlled by the lab room controller to provide the correct Laboratory pressure and ventilation rates.

10. Chilled Water Metering:

    i. The BAS system shall query and display the following points from the building chilled water meter, accessible at the BAS Operations Center:

        1) Supply and return temperature (degrees Fahrenheit)
        2) Flow rate (GPM)
        3) Instantaneous BTU value (tons)

11. Steam Metering, Pressure Monitoring, and Condensate Conductivity:

    i. The BAS system shall query and display the following points from the building steam meter, accessible at the BAS Operations Center:

        1) Temperature (degrees Fahrenheit)
        2) Flow rate (pounds/hour)
        3) Pressure (psi)

    ii. The BAS system shall query and display the following points from the building condensate meter, accessible at the BAS Operations Center:

        1) Flow rate (pounds/hour)
        2) Conductivity (microOhms)

1.02 LABORATORY CONTROLS SYSTEMS

A. Provide and install a laboratory airflow control system (LACS) to maintain laboratory airflow, pressurization, temperature and fume hood average face velocity. Room pressurization control shall utilize airflow tracking to vary the volume of supply air into the room and general exhaust air from the room to maintain both minimum ventilation and airflow balance. The room pressurization control system shall also maintain laboratory temperature.

B. The exhaust air volume of laboratory fume hoods shall be controlled by a standalone fume hood controller that is, seamlessly, incorporated into the room pressurization control system. The system shall include room controllers, fume hood controllers, supply and exhaust air flow control devices and control valves, all associated low voltage wiring, all pneumatic air lines and equipment if needed, and all necessary accessories to implement an integrated system as specified herein. Fume hood alarm monitor shall be an integral part of the system and sound a local user notification. System verification and documentation as specified under the commissioning section shall also be included.

C. All laboratory airflow control system components shall be products of a single manufacturer and be the responsibility of that manufacturer. Siemens Building Technologies or Alerton / Phoenix Lab Controls shall manufacture the laboratory airflow control system.

1.03 WARRANTY

A. Provide all services, materials and equipment necessary for the successful operation of the new BAS system for a period of one year after acceptance by WSU. Provide an extended warranty on all products for an additional 12 months for a total warranty of 24 months. Extended warranty applies to material components only; installation labor (if required) will be charged on an hourly basis.

B. All damper and valve actuators shall have a 5-year materials component warranty.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Siemens Building Technologies

B. Alerton Ascent Building Management System

2.02 NETWORKING COMMUNICATIONS

A. The design of the BAS shall network operator workstations and stand-alone DDC Controllers. The network architecture shall consist of three levels, a campus-wide (Management Level Network) Ethernet network based on TCP/IP protocol, high performance peer-to-peer building level network(s) and DDC Controller floor level local area networks with access being totally transparent to the user when accessing data or developing control programs.

B. The design of BAS shall allow the co-existence of new DDC Controllers with existing DDC Controllers in the same network without the use of third-party gateways or protocol converters.

C. Peer-to-Peer Building Level Network:

1. All operator devices shall have the ability to access all point status and application report data or execute control functions via the peer-to-peer network.

2. The peer-to-peer network shall support a minimum of 100 DDC controllers and PC workstations.

3. The system shall support integration of third party systems (PLC, chiller, boiler, etc.) via panel-mounted open protocol processor. This processor shall exchange data between the two systems for process control. All exchange points shall have full system functionality as specified herein for hardwired points.

D. Management Level Network:

1. All PCs shall simultaneously direct connect to the Ethernet and Building Level Network without the use of an interposing device.

2. Operator Workstation shall be capable of simultaneous direct connection and communication with BACnet and Apogee or Encompass networks without the use of interposing devices.

3. The Management Level Network shall not impose a maximum constraint on the number of operator workstations.

E. If the system will provide any Ethernet connectivity, it shall leverage the IP stack and be able to communicate with other devices in the same subnet and therefore must be layer 2 adjacent.

1. IP-based Protocols currently supported are limited to the following:

i. TCP/IP

ii. BACnet-IP (BACnet Ethernet is prohibited)

iii. DNP3-IP

iv. Modbus IP

v. All other IP protocols in use must be pre-approved by WSU Finance and Administration Information Systems (FAIS).

2.03 DDC AND HVAC MECHANICAL EQUIPMENT CONTROLLERS

A. The DDC and HVAC Mechanical Equipment Controllers shall reside on the Building Level Network.

B. DDC and HVAC Mechanical Equipment Controllers shall use the same programming language and tools. DDC and HVAC Mechanical Equipment Controllers, which require different programming language or tools on a network, are not acceptable.

2.04 DDC CONTROLLER

A. DDC Controllers shall be a 32-bit stand-alone, multi-tasking, multi-user, and real-time digital control processors. Controller size shall be sufficient to fully meet the requirements of this section, with built-in capacity for expansion of additional points.

B. Each DDC Controller shall have sufficient memory to support its own operating system and databases, including:

1. 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. Manual override monitoring

C. Each DDC Controller shall support firmware upgrades without the need to replace hardware.

D. DDC controllers shall provide a serial data communication port or USB port for operation of operator I/O devices such as industry standard printers, operator terminals, modems and portable laptop operator's terminals. DDC Controllers shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers or terminals.

E. 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 and gradual switches for analog control type points.

1. Switches shall be mounted either within the DDC Controllers key-accessed enclosure, or externally mounted with each switch keyed to prevent unauthorized overrides.

2. DDC Controllers shall monitor the status of all overrides and inform the operator that automatic control has been inhibited. DDC Controllers shall also collect override activity information for reports.

F. DDC Controllers shall provide local LED status indication for each digital output for constant, up-to-date verification of all point conditions without the need for an operator I/O device.

G. Each DDC Controller shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all panel components.

2.05 HVAC MECHANICAL EQUIPMENT CONTROLLERS

A. HVAC Mechanical Equipment Controllers shall be a 32-bit stand-alone, multi-tasking, multi-user, real-time digital control processors consisting of modular hardware with plug-in enclosed processors and built-in capacity for expansion of additional points.

B. Each HVAC Mechanical Controller shall have sufficient memory to support its own operating system and databases.

C. HVAC Mechanical Equipment Controllers shall provide local LED status indication for each digital output for constant, up-to-date verification of all point conditions without the need for an operator I/O device.

D. Each HVAC Mechanical Equipment Controller shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all components. The HVAC Mechanical Equipment Controller shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication.

2.06 DDC & HVAC MECHANICAL EQUIPMENT CONTROLLER RESIDENT SOFTWARE FEATURES

A. General:

1. The same names shall be used at the PC workstation.

2. All digital points shall have user defined two-state status indication (i.e. summer/winter).

3. The point naming scheme shall be generated by the WSU Environmental Controls Shop and supplied through the WSU Construction Manager.

B. Control Software Description:

1. The DDC and HVAC Mechanical Equipment Controllers shall have the ability to perform the following pre-tested control algorithms:

i. Two-position control

ii. Proportional control

iii. Proportional plus integral control

iv. Proportional, integral, plus derivative control

C. DDC and HVAC Mechanical Equipment Controllers shall provide the following energy management routines for the purpose of optimizing energy consumption while maintaining occupant comfort.

1. The system shall be capable of SSTO. Start-Stop Time Optimization (SSTO) shall automatically be coordinated with event scheduling. The SSTO program shall start HVAC equipment at the latest possible time that will allow the equipment to achieve the desired zone condition by time of occupancy. The SSTO program shall also shut down HVAC equipment at the earliest possible time before the end of the occupancy period, and still maintain desired comfort conditions.

i. The SSTO program shall operate in both the heating and cooling seasons.

ii. It shall be possible to apply the SSTO program to individual fan systems.

iii. The SSTO program shall operate on both outside weather conditions as well as inside zone conditions and empirical factors.

iv. The SSTO program shall meet the local code requirements for minimum outside air while the building is occupied.

2. Event Scheduling: Provide a comprehensive menu driven program to automatically start and stop designated points or groups of points according to a stored time.

i. It shall be possible to individually command a point or group of points.

ii. For points assigned to one common load group, it shall be possible to assign variable time delays between each successive start or stop within that group.

iii. The operator shall be able to define the following information:

1) Time, day
2) Commands such as on, off, auto, and so forth.
3) Time delays between successive commands.
4) There shall be provisions for manual overriding of each schedule by an appropriate operator.

iv. It shall be possible to schedule events up to one year in advance.

1) Scheduling shall be calendar based.
2) Holidays shall allow for different schedules.

3. Economizer Operation: The BAS shall control the position of the air handler relief, return, and outside air dampers. If the outside air-dry bulb temperature falls below changeover set point, the BAS will modulate the dampers to provide 100 percent outside air. The user will be able to quickly changeover to an economizer system based on dry bulb temperature and will be able to override the economizer cycle and return to minimum outside air operation at any time.

4. Automatic Daylight Savings Time Switchover: The system shall provide automatic time adjustment for switching to/from Daylight Savings Time.

5. Night setback control: The system shall provide the ability to automatically adjust setpoints for night control.

D. DDC and HVAC Mechanical Equipment Controllers shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.

1. A single process shall be able to incorporate measured or calculated data from any and all other DDC and HVAC Mechanical Equipment Controllers on the network. In addition, a single process shall be able to issue commands to points in any and all other DDC and HVAC Mechanical Equipment Controllers on the network. Database shall support 30 characters, English language point names, structured for searching and logs.

2. A process shall be able to directly send remote notifications via phone, text, or e-mail. This process shall occur within the application layer of communications.

3. DDC and HVAC Mechanical Equipment Controller shall be capable of comment lines for sequence of operation explanation.

E. Alarm management shall be provided to monitor and direct alarm information to operator devices. Each DDC and HVAC Mechanical Equipment Controller shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic and prevent alarms from being lost. At no time shall the DDC and HVAC Mechanical Equipment Controllers ability to report alarms be affected by either operator or activity at a PC workstation, local I/O device or communications with other panels on the network.

1. All alarm or point change reports shall include the point's English language description and the time and date of occurrence.

2. The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of six priority levels shall be provided for each point. Point priority levels shall be combined with user definable destination categories (PC, printer, DDC Controller, etc.) to provide full flexibility in defining the handling of system alarms. Each DDC and HVAC Mechanical Equipment Controller shall automatically inhibit the reporting of selected alarms during system shutdown and start-up. Users shall have the ability to manually inhibit alarm reporting for each point.

3. Alarm reports and messages will be directed to a user-defined list of operator devices or PCs based on time (after hours destinations) or based on priority.

4. In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 200 character alarm message to more fully describe the alarm condition or direct operator response.

5. In dial-up applications, operator-selected alarms shall initiate a call to a remote operator device.

F. A variety of historical data collection utilities shall be provided to manually or automatically sample, store and display system data for points as specified in the I/O summary.

1. Any point, physical or calculated may be designated for trending. Any point, regardless of physical location in the network, may be collected and stored in each DDC and HVAC Mechanical Equipment Controllers point group. Two methods of collection shall be allowed: either by a pre-defined time interval or upon a pre-defined change of value. Sample intervals of l minute to 7 days shall be provided. Each DDC and HVAC

Mechanical Equipment Controller shall have a dedicated RAM-based buffer for trend data and shall be capable of storing a minimum predetermined number of data samples. All trend data shall be available for transfer to a Workstation without manual intervention.

2. DDC and HVAC Mechanical Equipment Controllers shall also provide high-resolution sampling capability for verification of control loop performance.

G. DDC and HVAC Mechanical Equipment Controllers shall be capable of automatically accumulating and storing run-time hours for digital input and output points and automatically sample, calculate and store consumption totals for analog and digital pulse input type points, as specified in the point I/O schedule.

H. The peer-to-peer network shall allow the DDC and HVAC Mechanical Equipment Controllers to access any data from or send control commands and alarm reports directly to any other DDC and HVAC Mechanical Equipment Controller or combination of controllers on the network. DDC and HVAC Mechanical Equipment Controllers shall send alarm reports to multiple workstations. The peer-to-peer network shall also allow any DDC and HVAC Mechanical Equipment Controller to access, edit, modify, add, delete, back up, and restore all system point database and all programs.

I. The peer-to-peer network shall allow the DDC and HVAC Mechanical Equipment Controllers to assign a minimum of 50 passwords access and control priorities to each point individually. The logon password (at any PC workstation or portable operator terminal) shall enable the operator to monitor, adjust and control the points that the operator is authorized for. All other points shall not be displayed on the PC workstation or portable terminal (e.g. all base building and all tenant points shall be accessible to any base building operators, but only tenant points shall be accessible to tenant building operators). Passwords and priorities for every point shall be fully programmable and adjustable.

2.07 FLOOR LEVEL NETWORK APPLICATION SPECIFIC CONTROLLERS (ASC)

A. Each DDC Controller shall be able to extend its performance and capacity through the use of remote application specific controllers (ASCs) through Floor Level LAN Device Networks.

B. Each ASC shall operate as a stand-alone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each ASC shall be a microprocessor-based, multi-tasking, and real-time digital control processor.

2.08 CENTRAL SYSTEM CONTROLLERS:

A. Provide for control of central HVAC systems and equipment.

B. Each controller shall support a standalone, real-time operating system. Provide a time clock with battery backup to allow for stand-alone operation in the event communication with its DDC Controller is lost and to ensure protection during power outages.

C. All programs shall be field-customized to meet the user's exact control strategy requirements. Central System controllers utilizing pre-packaged or canned programs shall not be acceptable. As an alternative, provide DDC Controllers for all central equipment in order to meet custom control strategy requirements.

D. Programming of central system controllers shall utilize the same language and code as used by DDC Controllers to maximize system flexibility and ease of use. Should the system controller utilize a different control language, provide a DDC Controller to meet the specified functionality.

2.09 FLOOR LEVEL CONTROLLERS:

A. Provide for control of each piece of equipment, including, but not limited to, the following:

1. Variable Air Volume (VAV) boxes
2. Constant Air Volume (CAV) boxes
3. Dual Duct Terminal Boxes
4. Unit Conditioners
5. Heat Pumps
6. Unit Ventilators
7. Room and or Laboratory Pressurization

B. Each controller shall be capable of controlling the terminal device, independent of the terminal device manufacturer.

C. Controllers shall include all point inputs and outputs necessary to perform the specified control sequences. Analog outputs shall be industry standard signals such as 24V floating control, 3-15 psi pneumatic, 0-10VDC or 4-20 mA, allowing for interface to a variety of modulating actuators.

D. All controller sequences and operation shall provide closed loop control of the intended application. Closing control loops over the FLN, BLN or MLN is not acceptable.

2.10 PORTABLE OPERATOR'S TERMINAL (POT)

A. BAS shall allow for use of industry standard, commercially available portable operator terminals with a LCD display and a full-featured keyboard. The POT shall be handheld and shall connect directly (or via wireless network) with all DDC Controllers, HVAC & Mechanical Equipment Controllers, and Floor Level Network Controllers as described below. Provide a user-friendly, English language-prompted interface for quick access to system information, not codes requiring look-up charts.

B. Functionality of the Portable Operator's Terminal when accessing-system information from any DDC Controller:

1. Access all DDC Controllers and ASCs on the network.

2. Backup and/or restore DDC Controller databases for all system panels, not just the DDC Controller connected to.

3. Display all point, selected point and alarm point summaries.

4. Display trending and totalization information.

5. Add, modify and/or delete any existing or new system point.

6. Command, change setpoint, enable/disable any system point.

7. Program and load custom control sequences as well as standard energy management programs.

8. Acknowledge alarms.

C. Functionality of the Portable Operator's Terminal when accessing-system information from any application specific controller:

1. Provide status, setup and control reports.

2. Modify, select and store controller database.

3. Command, change setpoint, enable/disable any controller point.

D. Connection of a POT to a DDC or HVAC & Mechanical Equipment Controller, or ASC Controller shall not interrupt nor interfere with normal network operation in any way, prevent alarms from being transmitted or preclude centrally initiated commands and system modification.

E. Portable operator terminal access to controller shall be password-controlled. Password protection shall be configurable for each operator based on function, points (designating areas of the facility), and edit/view capability.

2.11 WORKSTATION OPERATOR INTERFACE

A. Basic Interface Description

1. Operator workstation interface software shall minimize operator training through the use of English language prompting, 30-character English language point identification, on-line help, and industry standard PC application software. Interface software shall simultaneously communicate with Building Level Networks and share data between any of the networks. The software shall provide, as a minimum, the following functionality:

i. Real-time graphical viewing and control of environment

ii. Scheduling and override of building operations

iii. Collection and analysis of historical data

iv. Point database editing, storage and downloading of controller databases.

v. Alarm reporting, routing, messaging, and acknowledgment

vi. Display dynamic data trend plot.

vii. Must be able to run multiple plots simultaneously.

viii. Each plot must be capable of supporting 10 pts/plot minimum.

ix. Must be able to command points directly off dynamic trend plot application.

x. Definition and construction of dynamic color graphic displays.

xi. Program editing

xii. Transfer trend data to third-party software.

xiii. Scheduling reports

xiv. Operator Activity Log

xv. Open communications via web-based technologies.

xvi. Compatible with Windows 7 or higher operating systems.

2. Use existing graphical user interface, which shall minimize the use of keyboard through the use of a mouse or similar pointing device and "point and click" approach to menu selection.

3. The software shall provide a multi-tasking type environment that allows the user to run several applications simultaneously. BAS software shall run on current and supported Windows server software such as Windows 2012 or higher. These Windows applications shall run simultaneously with the BAS software. The mouse or Alt-Tab keys shall be used to quickly select and switch between multiple applications. The operator shall be able to work in Microsoft Word, Excel, and other Windows-based software packages while concurrently annunciating on-line BAS alarms and monitoring information.

4. Provide functionality such that any of the following may be performed simultaneously on-line, and in any combination, via user-sized windows. Operator shall be able to drag and drop information between applications, reducing the number of steps (i.e. Click on a point on the alarm screen and drag it to the dynamic trend graph application to initiate a dynamic trend).

   i. Dynamic color graphics and graphic control.

   ii. Alarm management, routing to designated locations, and customized messages.

   iii. Year in advance event and report scheduling.

   iv. Dynamic trend data definition and presentation.

   v. Graphic definition and construction.

   vi. Program and point database editing on-line.

5. Report shall be accomplished via Windows Print Manager, allowing use of network printers.

6. Operator specific password access protection shall be provided to allow the user/manager to limit workstation control, display and data base manipulation capabilities as deemed appropriate for each user, based upon an assigned password. Operator privileges shall "follow" the operator to any workstation logged onto (up to 999 user accounts shall be supported).

7. Reports shall be generated on demand or via pre-defined schedule and directed to CRT displays, printers or disk. As a minimum, the system shall allow the user to easily obtain the following types of reports:

i. A general listing of all or selected points in the network

ii. List of all points currently in alarm

iii. List of all points currently in override status

iv. List of all disabled points

v. List of all points currently locked out

vi. List of user accounts and access levels

vii. List all weekly schedules

viii. List of holiday programming

ix. List of limits and dead bands

x. Custom reports from 3rd party software

xi. System diagnostic reports including, list of DDC panels on line and communicating, status of all DDC terminal unit device points

xii. List of programs

B. Scheduling and Override:

1. Provide a calendar type format for simplification of time-of-day scheduling and overrides of building operations. Schedules reside in the PC workstation, DDC Controller, and HVAC Mechanical Equipment Controller to ensure time equipment scheduling when PC is off-line; PC is not required to execute time scheduling. Provide override access through menu selection or function key. Provide the following spreadsheet graphic types as a minimum:

i. Weekly schedules

ii. Zone schedules, minimum of 200 unique zones

iii. Scheduling for up to 365 days in advance

iv. Schedule reports to print at PC

v. Collection and Analysis of Historical Data

vi. Provide trending capabilities that allow the user to easily monitor and preserve records of system activity over an extended period of time. Any system point may be trended automatically at time-based intervals or change of value, both of which shall be user-definable. Trend data may be stored on hard disk for future diagnostics and reporting.

Additionally, trend data may be archived to network drives or removable disk media for future retrieval.

vii. Trend data reports shall be provided to allow the user to view all trended point data. Reports may be customized to include individual points or predefined groups of at least six points. Provide additional functionality to allow predefined groups of up to 250 trended points to be easily transferred on-line to Microsoft Excel. DDC contractor shall provide custom designed spreadsheet reports for use by the owner to track energy usage and cost, equipment run times, equipment efficiency, and/or building environmental conditions. DDC contractor shall provide setup of custom reports including creation of data format templates for monthly or weekly reports.

C. Dynamic Color Graphic Displays:

1. Create color graphic floor plan displays and system schematics for each piece of mechanical equipment, including air handling units, chilled water systems and hot water boiler systems, and room level terminal units, shall be provided by the BAS contractor as indicated in the point I/O schedule of this specification to optimize system performance, analysis and speed alarm recognition. Contact WSU Representative for color selection input.

2. The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection or text-based commands. Graphics software shall permit the importing of AutoCAD or scanned pictures for use in the system.

3. Dynamic temperature values, humidity values, flow values and status indication shall be shown in their actual respective locations and shall automatically update to represent current conditions without operator intervention and without pre-defined screen refresh rates.

i. Sizable analog bars shall be available for monitor and control of analog values; high and low alarm limit settings shall be displayed on the analog scale. The user shall be able to "click and drag" the pointer to change the setpoint.

ii. Provide the user the ability to display blocks of point data by defined point groups; alarm conditions shall be displayed by flashing point blocks.

iii. Equipment state can be changed by clicking on the point block or graphic symbol and then selecting the new state (on/off) or setpoint.

iv. State text for digital points can be defined up to eight characters.

4. The windowing environment of the PC operator workstation shall allow the user to simultaneously view several applications at a time to analyze total building operation or to allow the display of a graphic associated with an alarm to be viewed without interrupting work in progress.

D. System Configuration and Definition:

1. Network wide control strategies shall not be restricted to a single DDC Controller or HVAC Mechanical Equipment controller, but shall be able to include data from any and all other network panels to allow the development of Global control strategies.

2. Provide automatic backup and restore of all DDC controller and HVAC Mechanical Equipment controller databases on the workstation hard disk. In addition, all database changes shall be performed while the workstation is on-line without disrupting other system operations. Changes shall be automatically recorded and downloaded to the appropriate DDC Controller or HVAC Mechanical Equipment Controller. Changes made at the DDC Controllers or HVAC Mechanical Equipment Controllers shall be automatically uploaded to the workstation, ensuring system continuity.

3. System configuration, programming, editing, graphics generation shall be performed on-line. If programming and system back up must be done with the PC workstation off-line, the BAS contractor shall provide at least 2 operator workstations.

E. Alarm Management:

1. Alarm Routing shall allow the user to send alarm notification to selected printers or PC location based on time of day, alarm severity, or point type.

2. Alarm Notification shall be provided via two alarm messages to distinguish between routine maintenance-type alarms and critical alarms. These alarm messages shall be displayed when user is working in other Windows programs. The BAS alarm display screen shall be displayed when the user clicks on the alarm message.

3. Alarm Display shall list the alarms with highest priority at the top of the display. The alarm display shall provide selector buttons for display of the associated point graphic and message. The alarm display shall provide a mechanism for the operator to sort alarms.

4. Alarm messages shall be customizable for each point to display detailed instructions to the user regarding actions to take in the event of an alarm.

2.12 FIELD DEVICES

A. Provide instrumentation as required for monitoring, control or optimization functions.

B. Temperature Sensors:

1. Digital room sensors shall have LCD display, day / night override button, and setpoint adjustment override options. The setpoint adjustment can be software limited by the automation system to limit the amount of room adjustment.

2. Monitoring range: 55° to 95° F (13° to 35°C)

3. Liquid immersion temperature:

   Monitoring range: -40/240°F

4. Duct (single point) temperature:

   Monitoring range: -40/240°F

5. Duct Average temperature:

   Monitoring range: -40/240°F

   Sensor Probe Length: 25’ L (7.3m)

6. Outside air temperature:

   Monitoring range: -40/240°F

C. Liquid Differential Pressure Transmitter:

1. Provide with a 3-way valve manifold

2. Ranges: As Needed

3. Output: 4 – 20 mA DC

4. Calibration Adjustments: Zero and span

5. Accuracy: ±-0.2% of span

6. Linearity: ±-0.1% of span

7. Hysteresis: ±-0.05% of span

D. Differential pressure:

1. Unit for fluid flow proof shall be Penn P74.

Range:	8 to 70 psi
Differential:	3 psi
Maximum differential pressure:	200 psi
Maximum pressure:	325 psi

2. Unit for airflow shall be Siemens Building Technologies SW141.

Set point ranges:	0.5” WG to 1.0” WG (124.4 to 248.8 Pa)
	1.0” WG to 12.0” WG (248.8 to 497.6 Pa)

E. Static pressure sensor:

1. Range:	0 to .5” WG (0 to 124.4 Pa)
	0 to 1” WG (0 to 248.8 Pa)
	0 to 2” WG (0 to 497.7 Pa)
	0 to 5” WG (0 to 1.2 kPa)
	0 to 10” WG (0 to 2.5 kPa)
2. Output signal:	4 – 20 mA VDC
3. Combined static error:	0.5% full range
4. Operating temperature:	-40º to 175º F (-40C to 79.5ºC)

F. Air Pressure Sensor:

1. Range:	0 to 0.1 in. water (0 to 24.9 Pa)
	0 to 0.25 in. water (0 to 63.2 Pa)
	0 to 0.5 in. water (0 to 124.5 Pa)
	0 to 1.0 in. water (o to 249 Pa)
	0 to 2.0 in water 90 to 498 Pa)
	0 to 5.0 in. water (0 to 1.25 kPa)
	0 to 10.0 in. water (0 to 2.49 kPa)

2. Output signal: 4 to 20 mA
3. Accuracy: ±1.0% of full scale

G. Humidity Sensors:

1. Range: 0 to 100% RH
2. Sensing element: Bulk polymer
3. Output signal: 4 – 20 mA DC
4. Accuracy: At 77°F (25ºC) ± 2% RH

H. Insertion Flow Meters (Equal to Onicon Series F-1210 or Sparling Tiger Mag FM 656):

1. Sensing method: Impedance Sensing
2. Accuracy: ± 2% of Actual Reading
3. Maximum operating pressure: 400 PSI
4. Output signal: 4 – 20 mA

I. Pressure to Current Transducer: Adjustable and sized accordingly

1. Range: 3 to 15 psig (21 to 103 kPa) or
   3 to 30 psig (21 to 207 kPa)
2. Output signal: 4 – 20 mA
3. Accuracy: ± 1% of full scale (± 0.3 psig)

J. Control Valves:

1. Steam applications: Control Valves shall be Normally Open (N/O); Fail State shall be N/O.
   i. Belimo or Siemens Globe Valve with stainless steel trim.
2. Floor-level Control: Specify Siemens Pressure-Independent Control Valves (PICV); no exceptions.
3. Energy Valves: Specify ONICON, including temperature and flow sensing to calculate BTU/h, inlet and outlet temperature, delta T, and water flow rates.

4. Globe / Characterized Ball Valves: 2” - 6”:

i.	Range:	40:1(minimum)
ii.	Flow characteristics:	Modified, equal percentage, linear
iii.	Control action:	Normal Open or Closed, as selected
iv.	Medium:	Steam, water, glycol
v.	Body type:	Screwed ends 2” and smaller, flanged Valves 2½” and larger
vi.	Body material:	Bronze
vii.	Body trim:	Bronze
viii.	Stem:	Stainless Steel
ix.	Actuator:	0-10 VDC, 4-20 MA or 2 position
		24 VAC/120VAC

5. Automatic Temperature Control Valves in water lines: Specify Siemens Pressure-Independent Control Valves (PICV), sized for minimum 25% of the system pressure drop or 5 psi, whichever is less.

K. Damper Actuators:

1. Electric Control:

   i. Alerton/Honeywell

   ii. Siemens Building Technologies OpenAir direct-coupled actuators

   iii. Belimo Inc. direct-coupled actuators

2. Damper actuators shall be brushless DC Motor Technology with stall protection, bi-directional, fail safe spring return, all metal housing, manual override, independently adjustable dual auxiliary switch.

   i. Damper actuators only shall be provided with a 5-year manufacturer’s warranty.

   ii. The actuator assembly shall include the necessary hardware and proper mounting and connection to a standard ½ inch diameter shaft or damper blade.

3. All actuators having more than 100 lb.-in torque output shall have a self-centering damper shaft clamp that guarantees concentric alignment of the

actuator's output coupling with the damper shaft. The self-centering clamp shall have a pair of opposed "v" shaped toothed cradles; each having two rows of teeth to maximize holding strength. A single clamping bolt shall simultaneously drive both cradles into contact with the damper shaft. Utilize friction-enhancing tape on shafts that do not provide flats for contact lock.

4. All actuators having more than a 100 in-lb. torque output shall accept a 1 inch diameter shaft directly, without the need for auxiliary adapters.

2.13 MISCELLANEOUS DEVICES

A. Low Temperature Safeties: (Freeze stats)

1. Install freeze stats as indicated on the plans.

i. Upon detection of low temperature, the freeze stats shall stop the associated supply fans and return the automatic dampers to their normal position. Provide manual reset.

ii. Provide input point to BAS for monitoring.

iii. Installation to incorporate a serviceable testing loop that allows for insertion of element loop into a 4-inch throat vessel for calibration.

B. Electronic Airflow Measurement Stations and Transmitters (at duct locations):

1. Stations:

i. Each insertion station shall contain an array of velocity sensing elements and straightening vanes.

ii. The velocity sensing elements shall be of the RTD or thermistor type. The sensing elements shall be distributed across the duct cross section in a quantity to provide accurate readings.

iii. The resistance to airflow through the airflow measurement station shall not exceed 0.08 inches water gage at airflow of 2,000 fpm.

iv. Station construction shall be suitable for operation at airflow of up to 5,000 fpm over a temperature range of 40 to 120 degrees F, and accuracy shall be plus or minus 3 percent over a range of 125 to 2,500 fpm scaled to air volume.

v. Each transmitter shall produce a linear, temperature compensated 4 to 20 mA DC, output corresponding to the required velocity pressure measurement.

C. Current Sensing Relay:

1. Provide solid-state, adjustable, current operated relay. Provide a relay, which changes switch contact state in response to an adjustable set point value of current in the monitored A/C circuit.

2. Adjust the relay switch point so that the relay responds to motor operation under load as an “on” state and so that the relay responds to an unloaded running motor as an “off” state. A motor with a broken belt is considered an unloaded motor.

3. Provide for status device for all fans and pumps.

D. CO_2 sensors

1. Provide space or duct type as required. Outdoor units shall be provided with heater or proper temperature compensation. Provide visible display.

2. Range: Range 0-2000 ppm

3. Response Time: 60 seconds for 90% step change

4. Accuracy: ± 30 ppm (± 2% of measured value)

E. Liquid Pressure Sensors

1. Provide materials as required for the process media. Provide steam isolation loop on steam pressure sensing. Provide isolation valve.

2. Differential Pressure Sensors: Specify 3-valve isolation manifolds (supply, return, and equalizing).

   i. Static inlet pressures ≤ 150 psig: Remote wired pressure sensors with plug in cables.

   ii. Static inlet pressures > 150 psig: Single element sensors are required.

3. Accuracy: ± 2% of range

F. Control Dampers

1. Standard applications < 3000 FPM and 5” W.C. close off: Ruskin CD-46 or Honeywell D2 Ultra Low Class II Leakage Dampers

2. Applications < 4000 FPM and 8” W.C. close off: Ruskin CD-60 or Honeywell D1 Airfoil Extremely Low Leakage Class 1 Dampers

G. VFD Control:

1. See Section 26 29 23 “Variable-Frequency Motor Controllers.”

2.14 LABORATORY SUPPLY AND EXHAUST AIR TERMINALS

A. Siemens Building Technologies laboratory supply and exhaust air terminals:

1. Laboratory terminal units and/or Venturi air valves shall provide turndown ratios of 5 to 1 for fume hood exhaust terminals and adequate turndown for room supply and general exhaust terminals. Adequate turndown to assure that the airflows specified can be maintained. All terminals shall be controlled to be pressure independent and include actual airflow measurement feedback as an integral part of their control process. Minimum airflow measurement accuracy shall be +/- 5% of actual reading over the entire rated airflow range of each device. Minimum to maximum terminal airflow (or vice versa) shall be attained in less than 1 second.

2. Exhaust airflow measurement shall be provided by airflow sensing techniques that are not likely to obstruct the exhaust duct or become inoperative due to the accumulation of chemical deposits.

3. All supply air terminals shall be constructed of minimum 20 gauge-galvanized steel. Damper shafts shall be solid stainless steel with Teflon or Teflon infused aluminum bearings. Supply terminals must be capable of 100% shut-off to accommodate smoke control requirements. Supply terminal air leakage shall not exceed 2% of design airflow at 4 inches w.g. positive static pressure.

4. All general exhaust terminals shall be constructed of 316L stainless steel or coated with corrosion resistant Teflon (can also be 20 gage galvanized steel if required). Damper shafts shall be solid stainless steel with Teflon bearings.

5. All FHET (Fume Hood Exhaust Terminals) shall be constructed of 316L stainless steel or coated with corrosion resistant Teflon. Damper shafts shall be solid stainless steel with Teflon bearings.

6. All terminals shall have a pressure drop of 0.3 inch or less at the maximum rated airflow.

7. A loss, increase and/or decrease of airflow shall be transmitted to the fume hood or room controller as appropriate.

B. Alerton / Phoenix Lab Controls laboratory supply and exhaust air terminals:

1. For applications > 100 CFM, the airflow control device shall be a Venturi valve. Venturi valves shall not be used for applications ≤ 100 CFM.

2. Obtain approval from WSU Engineering Services for all Phoenix Valve applications other than fume hoods.

3. The airflow control device shall be pressure independent over its specified differential static pressure operating range. An integral pressure independent assembly shall respond and maintain specific airflow within one second of a change in duct static pressure irrespective of the magnitude of pressure and/or flow change or quantity of airflow controllers on a manifold system.

4. No minimum entrance or exit duct diameters shall be required to ensure accuracy and/or pressure independence.

5. No rotational/axial orientation requirements shall be required to ensure accuracy and/or pressure independence.

6. The airflow control device shall maintain pressure independence regardless of loss of power.

7. The airflow control device shall be constructed of one of the following four types:

   i. Class A: The airflow control device for non-corrosive airstreams, such as supply and general exhaust, shall be constructed of 16-gauge aluminum. The device's shaft and internal “S” link shall be made of 316 stainless steel. The shaft support brackets shall be made of galvaneal (non-shutoff valves) or 316 stainless steel (shutoff valves). The pivot arm shall be made of aluminum (for non-shutoff valves) and 303/304 stainless (for shut off valves). The pressure independent springs shall be a spring-grade stainless steel. All shaft bearing surfaces shall be made of a PP (polypropylene) or PPS (polyphenylene sulfide) composite. Sound attenuating devices used in conjunction with general exhaust or supply airflow control devices shall be constructed using 24 gauge galvanized steel or other suitable material used in standard duct construction. No sound absorptive materials of any kind shall be used.

   ii. Class B: The airflow control device for corrosive airstreams, such as fume hoods and biosafety cabinets, shall have a baked-on, corrosion-resistant phenolic coating. The device's shaft shall be made of 316 stainless steel with a Teflon coating. The shaft support brackets shall be made of 316 stainless steel. The pivot arm and internal “S” link shall be made of 316 or 303 stainless steel. The pressure independent springs shall be a spring-grade stainless steel. The internal nuts, bolts and rivets shall be stainless steel. All shaft bearing surfaces shall be made of PP (polypropylene) or PPS (polyphenylene sulfide) composite.

   iii. Class C: The airflow control device for highly corrosive airstreams shall be constructed as defined as Class B. In addition, these devices shall have no exposed aluminum or stainless steel components. Shaft support brackets, pivot arm, and pressure independent springs shall have a baked-on, corrosion-resistant phenolic coating in addition to the materials defined in 2.2.B.6.B. The internal "S" link, nuts, bolts, and rivets shall be epoxy phenolic coated stainless steel. Only devices clearly defined as "high corrosion resistant" on project drawings will require this construction.

iv. Class D: The airflow control device for extremely corrosive airstreams, such as acid digestion fume hoods, shall have a PVDF (polyvinylidene fluoride fluoropolymer) coating. The device's shaft shall be made of 316 stainless steel with a Teflon coating. The shaft support brackets shall be made of 316 stainless steel with PVDF coating. The pivot arm and internal mounting link shall be made of 316 or 303 stainless steel with PVDF coating. The pressure independent springs shall be a spring-grade stainless steel with PVDF coating. The internal nuts, bolts and rivets shall be stainless steel with PVDF coating. All shaft bearing surfaces shall be made of Teflon or PPS (polyphenylene sulfide) composite. Only devices clearly defined as "extremely corrosion resistant" on project drawings will require this construction.

8. Actuation

i. For electrically actuated VAV operation, a CE certified electronic actuator shall be factory mounted to the valve. Loss of main power shall cause the valve to position itself in an appropriate failsafe state. Options for these failsafe states include: normally open-maximum position, normally closed-minimum position and last position. This position shall be maintained constantly without external influence, regardless of external conditions on the valve (within product specifications).

ii. For pneumatically-actuated two-position or VAV operation, a pneumatic actuator shall be factory mounted to the valve. Loss of pneumatic main air or control power shall cause normally open valves to fail to maximum position and normally closed valves to fail to minimum position.

iii. Constant volume valves do not require actuators.

9. The controller for the airflow control devices shall be microprocessor based and operate using peer-to-peer control architecture. The room-level airflow control devices shall function as a standalone network.

10. There shall be no reliance on external or building-level control devices to perform room-level control functions. Each laboratory control system shall have the capability of performing fume hood control, pressurization

control, temperature control, humidity control, and implement occupancy and emergency mode control schemes.

11. The LACS shall have the option of digital integration with the BMS.

12. NVLAP Accreditation (Lab Code 200992-0)

i. Each airflow control device shall be factory characterized on air stations NVLAP Accredited (a program administered by NIST) to ISO/IEC 17025:2005 standards.

ii. Each airflow control device shall be factory characterized to the job specific airflows as detailed on the plans and specifications using NVLAP Accredited air stations and instrumentation having a combined accuracy of no more than ±1% of signal (5,000 to 250cfm), ±2% of signal (249 to 100cfm) and ±3% of signal (199 to 35cfm). Electronic airflow control devices shall be further characterized and their accuracy verified to ±5% of signal at a minimum of 48 different airflows across the full operating range of the device.

iii. Each airflow control device shall be marked with device-specific factory characterization data. At a minimum, it should include the room number, tag number, serial number, model number, eight-point characterization information (for electronic devices), date of manufacture and quality control inspection numbers. All information shall be stored by the manufacturer for use with as-built documentation. Characterization data shall be stored indefinitely by the manufacturer and backed up off site for catastrophic event recovery.

2.15 LABORATORY ROOM CONTROLLER

A. Siemens Building Technologies laboratory room controllers:

1. Room airflow tracking shall be accomplished via actual measurement of terminal unit airflow. Controllers, which track within a range of airflow’s versus actual airflow setpoints shall not be acceptable.

2. Each laboratory room controller shall be specifically designed for control of laboratory temperature, (humidity and differential pressure monitoring where applicable) and room ventilation. Each controller shall be a microprocessor-based, multi-tasking, real-time digital control processor. Control sequences shall be included as part of the factory supplied software. These sequences shall be field customized by adjusting parameters such as control loop algorithm gains, temperature setpoint, alarm limits, airflow differential setpoint, and pressurization mode. Closed

loop Proportional Integral Derivative (PID) control algorithms shall be used to maintain temperature and airflow offset set points.

3. All databases and programs shall be stored in non-volatile EEPROM, EPROM and PROM memory, or a minimum of 72-hour battery backup shall be provided. All controllers shall return to full normal operation without any need for manual intervention after a power failure of unlimited duration.

B. Alerton / Phoenix Lab Controls provided laboratory room controllers:

1. Only for use in air flow applications > 100 CFM.

2. The airflow control device shall be a microprocessor-based design and shall use closed loop control to linearly regulate airflow based on a digital control signal. The device shall generate a digital feedback signal that represents its airflow.

3. The airflow control device shall store its control algorithms in non-volatile, re-writeable memory. The device shall be able to stand-alone or to be networked with other room-level digital airflow control devices using an industry standard protocol.

4. Room-level control functions shall be embedded in and carried out by the airflow device controller using distributed control architecture. Critical control functions shall be implemented locally; no room-level controller shall be required.

5. The airflow control device shall use industry standard 24 VAC power.

6. The airflow control device shall have provisions to connect a notebook PC commissioning tool and every node on the network shall be accessible from any point in the system.

7. The airflow control device shall have built-in integral input/output connections that address fume hood control, temperature control, humidity control occupancy control, emergency control, and non-network sensors switches and control devices. At a minimum, the airflow controller shall have:

   i. Three universal inputs capable of accepting 0 to 10 VAC, 4 to 20 mA, 0 to 65 K ohms, or Type 2 or Type 3 10 K ohm @ 25 degree C thermistor temperature sensors.

   ii. One digital input capable of accepting a dry contact or logic level signal input.

iii. Two analog outputs capable of developing either a 0 to 10 VAC or 4 to 20 mA linear control signal.

iv. One Form C (SPDT) relay output capable of driving up to 1 A @ 24 VAC/VAC.

8. The airflow control device shall meet FCC Part 15 Subpart J Class A, CE, and CSA Listed per file #228219.

2.16 VARIABLE AIR VOLUME FUME HOOD CONTROLLER

A. Siemens Building Technologies variable air volume fume hood controller:

1. Provide a UL 916 listed individual VAV fume hood controller for each fume hood, which shall maintain the face velocity setpoint (adjustable) in response to sash position.

2. In operation, the VAV fume hood control process consists of calculating the fume hood exhaust flow necessary to provide the required average face velocity at any sash position based upon actual sash position and total fume hood open area. The controller shall then position the fume hood exhaust terminal damper to attain the required exhaust airflow in conjunction with constant feedback from an integral exhaust airflow sensor. The controller shall perform this exhaust airflow calculation ten times per second to ensure maximum speed of response to changes in sash position. Even when no change has occurred in sash position since the previous calculation, the controller shall continue to position the exhaust terminal damper in response to its airflow measurement feedback to ensure that the required fume hood exhaust is always maintained independently of variations in exhaust system static pressure or room conditions that could otherwise affect fume hood exhaust airflow.

i. The VAV fume hood controller shall initiate corrective action immediately upon sash movement and be completed when sash movement stops so as to restore the required average face velocity within 3 seconds after completion of sash movement.

ii. A "Sash Alert" feature shall provide periodic beeps at the Operator Display Panel when the sash remains open above the recommended safe working height (adjustable) for an adjustable period of time. This feature shall enhance fume hood safety operation and energy efficiency. This feature shall include a beep interval and be capable of being implemented on individual fume hoods as desired by authorized owner personnel.

B. Alerton / Phoenix Lab Controls provided variable air volume fume hood controller:

1. A fume hood monitor shall be provided to receive the sash sensor output, and presence and/or motion signal. This same monitor shall generate an exhaust airflow control signal for the appropriate airflow control device in order to provide a constant average face velocity. Audible and separate visual alarms shall be provided for flow alarm and emergency exhaust conditions. The fume hood monitor shall incorporate the following capabilities:

   i. (Optional) LED display with the ability to display one of the following measurements:

      1) Cubic feet per minute (CFM)
      2) Meters cubed per hour (m3/h)
      3) Liters per second (l/s)
      4) Feet per minute (fpm)
      5) Meters per second (m/s)

   ii. Alarm Muting option, which silences the audible alarm for an adjustable time period when the mute button is pushed. If another alarm is generated during the mute period, the new alarm will override the mute delay and the alarm will sound again.

   iii. Auto Alarm Muting option, which sets the alarm to mute automatically after 20 seconds.

   iv. Emergency Exhaust button with LED, which activates an emergency exhaust mode. In this mode, the exhaust air is at its maximum flow. When activated, the alarm will sound and the LED will flash. To activate emergency exhaust mode, push the button. Push the button again to cancel emergency exhaust mode.

   v. Flow Alarm LED, which illuminates to indicate an unsafe airflow condition. The audible alarm will also activate and may be muted.

   vi. Broken retracting cable alarm, an audible alarm with a flashing LED that indicates whether a vertical sash sensor cable is detached, thereby ensuring the fume hood users’ safety.

   vii. (Optional) Diversity Alarm LED that can be activated locally or from the BMS system. No audible alarm will be generated at the fume hood monitor.

   viii. (Optional) Energy waste alarm option, which generates a local visual and audible alarm to notify when the fume hood sash is open beyond its minimum flow position and the lights in the room are off. When activated, the LED display will show “ENRG” and the audible alarm will sound until the sash is closed. The light levels at which the alarm is both initiated and cancelled shall be configurable.

ix. (Optional) Fume hood decommissioning option, which commands the exhaust flow through the fume hood to the minimum allowed by the exhaust valve when the sash is fully closed and no chemicals are present in the hood. The mode shall be initiated by either a pushbutton sequence on the fume hood monitor, external momentary switch input to the fume hood monitor, or a network command. When activated, the LED display will show "OFF," and the exhaust valve will move to its minimum position or shutoff position. Safety shall be built into the decommission option, whereby opening the fume hood sash will automatically return the fume hood exhaust to an in-use operating volume as determined by the sash sensor. Fume hood decommissioning shall be a point that can be integrated to the BMS system.

2.17 FUME HOOD OPERATOR DISPLAY

A. Siemens Building Technologies Fume Hood Operator Display:

1. An operator display panel shall be provided for each fume hood to comply with laboratory safety standards. The operator display panel shall provide the following functionality:

i. Indicator lights that verify normal operation (green), marginal operation (yellow), and alarm condition (red). An alarm condition shall automatically be initiated for both high and low face velocity conditions.

ii. An audible alarm device shall also be initiated in response to an alarm condition. The audible alarm device shall be capable of being silenced by a user silence button; however, the alarm device shall automatically resound upon another alarm occurrence.

iii. A user initiated emergency purge functions shall initiate visual and audible alarm and increase the fume hood exhaust to maximum airflow. When the emergency purge button is depressed, a second time, the emergency sequence shall be terminated and fume hood control shall return to normal operation.

B. Alerton / Phoenix Lab Controls Fume Hood Operator Display:

1. Refer to Variable Air Volume Fume Hood Controller paragraph.

2.18 SASH SENSOR

A. Provide sash position sensors for each fume hood to indicate the actual position of each sash. The sash sensor shall be a precision linear device with repeatable location accuracy within 1/2 inch.

B. Sash sensor material shall be corrosion resistant.

C. Sash sensors shall allow complete and easy removal of the sashes for cleaning and maintenance.

D. Operational life of each sash sensor shall be a minimum of 1,000,000 full cycles.

E. Sash sensor failure shall be indicated as an alarm at the fume hood operator display panel.

END OF SECTION