Building Automation and Central Monitoring Systems

The following document describes the performance requirements for Building management system installations on all FSU campus locations. The specification sections shall be utilized in their entirety with the addition of specific mechanical control system diagrams, sequences, and point I/O summaries either added to this document or included in the project plans to form a complete project document. Refer to the APPLICATION SPECIFIC REQUIREMENTS FOR FSU BAS SYSTEMS section below and the Director of Utilities for current mechanical control system diagrams, sequences, and point I/O summaries available in electronic format for inclusion.

The University must maintain energy management, environmental control, monitoring and long term trend data to either meet the requirements of internal quality assurance departments, or the regulatory compliance requirements of government agencies such as FDA and EPA. The University provides this service centrally via the Central Utilities Plant (CUP) and Facilities Maintenance via building controls systems hardware and software manufactured by Siemens. Siemens software packages APOGEE, InfoCenter Suite and APOGEE GO located at CUP use client/server architecture and Web enabling software to allow multiple users, the ability to access real time facility performance data, alarms, command points as well as access trend data stored in a central database server across the campus Ethernet network. Point trend data generated by the University's APOGEE building automation system is imported into the InfoCenter Suite database via automatic file transfer over an Ethernet network. Users have may have access to APOGEE trends, real time graphics and data from their desktop workstations. Trend data can be retained indefinitely by archiving the data to disk based media after a specified time interval.
All university facilities shall utilize Siemens building control system hardware.
Central Utilities provides 24/7 monitoring of HVAC systems alarm and operational status. This monitoring is also supported via the building automation system to automatically escalate critical systems alarms via Remote Notification features(paging, email, etc.) to insure the maximum response.
The Central Utilities Section of the Physical Plant Department is responsible for the maintenance, operation and modification of the system including the addition of new applications to minimize training and support costs.

Typical applications, point information and systems to be controlled and monitored are described below

APPLICATION SPECIFIC REQUIREMENTS FOR FSU BAS SYSTEMS

Items described herein describe related work by others as well as the BAS contractor requirements.

GENERAL:

Buildings on campus will not require a workstation or portable operators terminal. Remote access to the APOGEE network shall be via the APOGE GO Web enabled software.

Each building shall be connected to the APOGEE network via the FSU campus backbone utilizing the Siemens AEM. Siemens will provide cat-v wiring from the nearest BLN panel to the main communications closet on the ground floor. Typically the electrical contractor will provide a raceway from the main comm. Closet to the BLN panel.

STEAM:

A steam flow meter must be installed on the high side steam pressure entering the building. The flow meter shall be Yokogawa or pre-approved equal. The meter should be flanged or wafer style with a visual local readout. The meter must be

sized to cover the range of steam flow with greater emphasis on low flow. Oversized meters will not be accepted.

Steam pressure transmitter on the high & low side of pressure regulators.

All pressure reducing stations PRV must use a globe valve with a electronic actuator connected to the Siemens system. The actuator should be normally closed, spring return. The speed of the actuator for full stroke must be less than 60 seconds The valve should be able to close of at a differential pressure of 150 psid. Low pressure steam (item # 2 above) will be used to maintain software control on the valve.

Provide valve position feedback for electronic PRV.

All electronic valves & actuators must have a five(5) year product warranty.

STEAM CONDENSATE:

If a flow meter is not installed on the steam supply then a steam condensate flow meter shall be installed on the line leaving the condensate tank returning to Central Utilities Plant.

On the return condensate line there should also be a two wire loop powered conductivity transmitter.

HVAC HOT WATER:

Provide hot water temperature on the inlet & outlet side of the heat exchanger.

Provide a conductivity transmitter on the closed hot water loop. The probe should be on the heat exchangers outlet side.

Provide a high temperature flow meter installed on the inlet side of the heat exchanger.

Hot water pump should use smart current switch to establish pump status.

Provide hot water heat exchanger with a domestic make-up water flow meter.

Heat exchanger control valve & actuator must be electronic.

All electronic valves & actuators must have a five(5) year product warranty.

HVAC CHILLED WATER:

Provide chilled water supply temperature from Central Plant side of building.

Provide chilled water supply temperature on building side after the de-coupler.

Provide chilled water return temperature leaving building.

Provide chilled water supply pressure sensor entering the building. This gauge shall have a visual dial type and 4-20ma output for connection to BAS system. Please note that this gauge will substitute for local dial type mechanical gauge thus saving on labor costs.

Provide chilled water return pressure leaving building. This gauge has a visual dial type and 4-20ma output for connection to BAS system. Please note that this gauge will substitute for local dial type mechanical gauge thus saving on labor costs.

Provide chilled water supply control valve on the building entering side. The valve should be a normally open two position electronic valve. Valve and actuator shall be electronic with feedback.

Provide chilled water return control valve on the building leaving side. This valve should be a modulating electronic valve similar to the supply valve.

Provide a two position chilled water bypass control valve in the decoupler. Valve actuator should be normally closed.

Provide a two position chilled water valve sized to be equal to the building incoming line and installed across the inlet & outlet side of one or both chilled water pumps. Valve actuator should be normally closed with feedback.
Provide chilled water flow unit that provides a 4-20ma output proportional to the flow.
Provide a differential pressure transducer at the farthest and highest location on the building chilled water loop. This differential pressure transducer is required to control the VFD chilled water pump speed. Transducer must be on the main chilled water supply & return header. Transducer must not be placed at the air handler chilled water supply & return line to prevent erroneous readings.
Provide chilled water differential pressure (inches) across building supply strainer.
Provide chilled water differential pressure (inches) across chilled water pump strainers.
All chilled water pumps must have individual drives. These drives must be fully approved at installation time (not under Beta testing) by Siemens to operate on the P1 LAN. Drives presently approved (10/01) for FSU installations are: Consult FSU Alan Peck for current list.
Control & monitor off VFD drives should be through the P1 LAN.
All electronic valves & actuators must have a five(5) year product warranty.

HVAC AIR HANDLERS (AHU):

1. Provide supply air temperature (4-20 ma) on AHU.
2. Provide return air temperature (4-20 ma) on AHU.
3. Provide mixed air temperature (4-20 ma) on AHU.
4. Provide air temperature between heating and cooling coils of AHU where applicable.
5. Provide return air humidity on AHU.
6. Provide supply air static pressure on AHU.
7. Provide static air pressure at about 2/3 the distance downstream of the major AHU air duct.
8. Provide CO2 level sensor on the return side of the AHU.
9. Provide fresh air Humidity (2% accuracy) on any one AHU in the building.
10. Provide fresh air modulating damper on the outdoor air intake.
11. Provide return air modulating damper (if required) on the return air for the AHU.
12. Provide fresh air flow measuring station on the AHU.
13. Provide analog differential air pressure (inches) across the AHU filters.
14. Provide approved VFD drives for the AHU. These drives must be fully compatible with the Siemens P1 LAN.
15. Provide electronic chilled water return valve. Valve actuator should be modulating normally open, spring return.
16. Provide electronic hot water valve (2-way or 3-way). Valve & actuator should be modulating normally closed, spring return.

All electronic valves & actuators must have a five(5) year product warranty.

EXHAUST FANS:

Exhaust fans that will not be interlocked with the restroom light switch must be controlled and monitored by the Siemens BAS system. Fan status should be monitored by a smart current sensor switch.

LABORATORY / ANIMAL LAB EXHAUST/SUPPLY HVAC SYSTEMS:

1. Laboratory supply and exhaust air valves must be controlled and/or monitored by the Siemens laboratory controls system. All Laboratory Variable or Constant Volume air valves to be electrically actuated Blade style as manufactured by Siemens. Siemens Venturi Valve specs are shown for reference only and shall be used only upon pre-approved circumstances by the Director of Utilities.
2. Constant Volume Fume Hood. (Preferred) Fume Hood alarm status and flow must be monitored. Constant volume fume hoods shall utilize valves as manufactured by Siemens with Flow monitoring.
3. Variable Volume Fume Hood. Fume Hood alarm status and flow must be monitored. Variable volume fume hoods shall utilize fast acting or slow acting variable volume air valves that are 24vac powered as manufactured by Siemens with Flow monitoring. All subsequent supply air valves in VAV fume hood lab shall require fast acting or slow actuation as described above as coordinated with Siemens.
4. Lab Room pressurization and temperature control shall be via the Siemens BAS system. Minimal Lab controlled/monitored points shall be: Room Temperature, Room Humidity, Supply Air Flow, Supply Air Valve Reheat Air Temperature, Exhaust Air Flow, Pressurization operation (via delta flow). Lab may be totally constant volume or constant volume hoods with variable volume supply and general exhaust valves based on Florida Energy Code and FSU requirements.
5. Energy Management strategies for VAV labs shall be incorporated into building control strategy for supply and exhaust systems.
6. Minimal Animal Lab monitored points shall be: Room Temperature, Room Humidity, Air Changes/hr, Lighting Status.
7. Standard Lab & Animal Lab trend and report features shall be implemented and verified with CUP.

FAN TERMINAL UNITS:

Most terminal equipment controllers (TEC's) fall in four categories; Variable air volume; Variable air volume with reheat; Variable air volume with reheat & run around fan; Fan coil unit with chilled water cooling & hot water reheat. All TEC's & damper actuators must be provided by Siemens.

Provide electronic control of hot water valves with a handle & position indicator.

When an application uses a fan it should have control & true status.

All TEC's except for variable air volume without reheat must have a supply air temperature.

Power transformers for the TEC's must be installed in the same room where the Siemens Modular Building Control (MBC) is installed. Also these transformers must be on an APC UPS.

All power transformers must be appropriately identified as to the LAN it is serving.

CITY WATER USAGE:

Total city water flow for the building must be measured using a flow meter connected to the building automation system. Manual isolation valves must be installed downstream & upstream of flow sensor.

EMERGENCY GENERATOR:

Emergency generator must be monitored to show analog value of battery voltage.

Monitoring of generator run status.

Monitoring of generator output (analog value) in amps when running under load.

Monitoring of generator radiator water temperature, analog value.

Monitoring of generator fuel level if system uses oil.

Monitoring of generator oil pressure (analog value).
All Siemens MBC's, MEC's must be connected to the emergency generator.

BUILDING ELECTRICAL USAGE:

Total building electrical usage must be monitored using a Siemens series 2000 Digital energy monitor.
The monitor should be accessible for fuse or CT replacement.

LIGHTING CONTROL:

All lighting controls, if installed, must be on the normally closed contacts for fail safe operation.

ELEVATOR ROOMS:

All elevator rooms must be monitored for room temperature & provide space control using TEC's
Elevator failure status should be picked up by the BAS system

CRITICAL ROOMS:

1. All critical rooms like server & node rooms must have a Direct Expansion (DX) unit as a backup. The DX backup & the chilled water cooling system should be connected to Siemens TEC's.
2. Cold Rooms and Warm Rooms shall be monitored for Temperature, Ref equipment status

AUDITORIUMS & CLASSROOMS:

1. Auditorium conference & classrooms must have motion sensors to confirm occupancy. These motion sensors should be connected to the BAS system for status and coordinated schedule
2. Motion sensors should be properly installed so that erroneous readings are not obtained.

END OF APPLICATION SPECIFIC REQUIREMENTS FOR FSU BAS SYSTEMS

Specification sections to be used in design start here. Coordination with Utilities and Siemens during design Development shall be initiated by the Design Consultant prior to commencing work for current applications and budget during project development.
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15900 BUILDING AUTOMATION SYSTEM

PART 1 - GENERAL

1.1 SCOPE

The intent of this specification is to provide a complete Building Automation System(BAS) designed to accomplish the sequences of operations. This specification describes standards in product and performance for all BAS systems installed at Florida State University facilities. All applicable standards described herein for this project shall be utilized unless otherwise stated.

The Building Automation System (BAS) manufacturer shall furnish and install a fully integrated building automation system, incorporating direct digital control (DDC) for energy management, equipment monitoring and control, and subsystems with open communications capabilities as herein specified.

The installation of the control system shall be performed under the direct supervision of the controls manufacturer with the shop drawings, flow diagrams, bill of materials, component designation or identification number and sequence of operation all bearing the name of the manufacturer. The installing manufacturer shall certify in writing, that the shop drawings have been prepared by the equipment manufacturer and that the equipment manufacturer has supervised their installation. In addition, the equipment manufacturer shall certify, in writing, that the shop drawings were prepared by their company and that all temperature control equipment was installed under their direct supervision.

All materials and equipment used shall be standard components, regularly manufactured for this and/or other systems and not custom designed specially for this project. All systems and components shall have been thoroughly tested and proven in actual use for at least two years.

BAS manufacturer shall be responsible for all BAS and Temperature Control wiring for a complete and operable system. All wiring shall be done in accordance with all local and national codes. Wiring shall be a combination of plenum wire not in conduit outside of mechanical rooms and wiring in conduit in mechanical rooms and as required by codes.

1. 2 WORK BY OTHERS

A. Mechanical contractor installs all wells, valves, taps, dampers, flow stations, etc. furnished by BAS manufacturer.
Mechanical contractor provides all control dampers and installation of same. Electronic actuators furnished and installed by BAS contractor.
All smoke, fire smoke, and fire dampers furnished complete with actuators and end switches by mechanical contractor. Wiring unless otherwise stated in other divisions shall be by BAS contractor.
All taps, tap valves are by mechanical contractor.
Access doors and installation are by mechanical contractor.

B. Electrical Contractor provides:
Emergency 120V power to all BAS an/or Temperature control panels
Wiring of all power feeds through all disconnect starters to electrical motor.
Wiring of any remote start/stop switches and manual or automatic motor speed control devices not furnished by BAS manufacturer
Line voltage wiring of any electrical sub-metering devices furnished by BAS manufacturer. Enclosure required for main building power monitor to be provided by electrical contractor with lockable door.

Products furnished but not installed under this section
Section 15xxx - Hydronic Piping:
Control Valves
Temperature Sensor Wells and Sockets
Flow Meters

Section 15xxx - Duct-work Accessories:
Air-flow Stations
Terminal Unit Controls

1.3 RELATED WORK

A. Division 01000 General and Special Conditions
B. Division 15000 Mechanical
C. Division 16000 Electrical

1.4 QUALITY ASSURANCE

A. The BAS system shall be furnished and installed by Siemens Building Technologies, Inc. Building Automation Division.

The BAS system shall be designed and installed, commissioned and serviced by manufacturer employed, factory trained personnel. Manufacturer shall have an in-place support facility within 50 miles of the site with technical staff, spare parts inventory and necessary test and diagnostic equipment. Distributors or licensed installing contractors are not acceptable.

The BAS manufacturer shall provide on site experienced project management for this work, responsible for direct supervision of the design, installation, start up and commissioning of the BAS.

B. The Bidder shall be regularly engaged in the manufacturing, installation and maintenance of BAS systems and shall have a minimum of ten (10) years of demonstrated technical expertise and experience in the manufacture, installation and maintenance of BAS systems similar in size and complexity to this project. A local maintained service organization consisting of competent servicepersons for a period

of not less than ten years and provide a list of 10 projects, similar in size and scope to this project, completed within the last five years.

C. Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of automatic temperature control systems and shall be manufacturer's latest standard design that complies with the specification requirements and BAS system manufacturer.

D. All BAS peer-to-peer network controllers, central system controllers and local user displays shall be UL Listed under Standard UL 916, category PAZX; Standard ULC C100, category UUKL7; and under Standard UL 864, categories UUKL, UDTZ, and QVAX. and be so listed at the time of bid. All floor level controllers shall comply, at a minimum, with UL Standard UL 91 6category PAZX; Standard UL 864, categories UDTZ, and QVAX. and be so listed at the time of Bid.

E. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.

F. The manufacturer of the building automation system shall provide documentation supporting compliance with ISO-9002 (Model for Quality Assurance in Production, Installation, and Servicing) and ISO-140001 (The application of well-accepted business management principles to the environment). The intent of this specification requirement is to ensure that the products from the manufacturer are delivered through a Quality System and Framework that will assure consistency in the products delivered for this project.

This system shall have a documented history of compatibility by design for a minimum of 15 years. Future compatibility shall be supported for no less than 10 years. Compatibility shall be defined as the ability to upgrade existing field panels to current level of technology, and extend new field panels on a previously installed network.

G. Compatibility shall be defined as the ability for any existing field panel microprocessor to be connected and directly communicate with new field panels without bridges, routers or protocol converters.

1. 5 SUBMITTALS

A. Submit 10 complete sets of documentation in the following phased delivery schedule:

1. Valve and damper schedules
2. Equipment data cut sheets
3. System schematics, including:
   A. sequence of operations
   B. point names
   C. point addresses
   D. interface wiring diagrams
   E. panel layouts.
   F. system riser diagrams
4. Auto-CAD compatible as-built drawings

B. Upon project completion, submit operation and maintenance manuals, consisting of the following:

Index sheet, listing contents in alphabetical order
Manufacturer's equipment parts list of all functional components of the system, Auto-CAD disk of system schematics, including wiring diagrams
Description of sequence of operations
As-Built interconnection wiring diagrams
Operator's Manual
Trunk cable schematic showing remote electronic panel locations, and all
trunk data
List of connected data points, including panels to which they are connected and input device (ionization detector, sensors, etc.)
Conduit routing diagrams

1.6 WARRANTY

A. Provide all services, materials and equipment necessary for the successful operation of the entire BAS system for a period of one year after beneficial use.

B. The adjustment, required testing, and repair of the system includes all computer equipment, transmission equipment and all sensors and control devices.

C. The on-line support services shall allow the local BAS subcontractor to dial out over telephone lines to monitor and control the facility's building automation system. This remote connection to the facility shall be within 2 hours of the time that the problem is reported. This coverage shall include normal business hours, after business hours, weekends and holidays.

If the problem cannot be resolved on-line by the local office, the national office of the BAS manufacturer shall have the same capabilities for remote connection to the facility. If the problem cannot be resolved with on-line support services, the BAS manufacturer shall dispatch the appropriate personnel to the job site to resolve the problem within 4 hours of the time that the problem is reported.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

Siemens Building Technologies, Inc. Tallahassee Branch Operations.

The contract drawings show the DDC control system design as specified herein. The existing central control and monitoring systems (Siemens Apogee System 600) shall be interfaced with the new control system in accordance with the I/O summary tables, control schematics, and/or I/O point lists shown on the contract drawings. The new DDC controllers shall be interfaced with the existing central control and monitoring system to allow reading of each process variable, or monitored point, and set point adjustment for each control loop from new graphical screens on the existing central control and monitoring system host. Programming of graphical screens on the existing central control and monitoring system shall be performed by the Contractor as a part of this project.

All commands issued by the existing central control and monitoring system shall be executed by the new DDC system.

No new graphical software package will be installed. No separate workstation will be added to existing campus wide system.

All DDC system I/O shall be graphically accessible on the existing central control and monitoring system.

Contractor will be responsible for successfully integrating into the existing workstations and existing graphical software by providing the specific requirements set forth in this section.

Modifications to DDC field panels and application specific controllers programs shall be accessible via the existing Siemens graphical software/workstations.

Modifications of equipment scheduling programs resident in the DDC field panels shall be accessible via the existing Siemens graphical software/workstations.

Building DDC system network diagnostics shall be accessible via the existing Siemens graphical software/workstations.

Automatic, unattended, storage and downloading of field panel programs and point databases shall be executed via the existing Siemens graphical software/workstations.

Notification of field panel point alarms shall be incorporated into existing Siemens graphical software/workstations alarm status screen.

Trended data from each field panel shall be accessible for uploading and archiving via the existing Siemens graphical software/workstations.

Field panel and field device failures shall be annunciated into existing Siemens graphical software/workstations alarm status screen.

Field panel and application specific controllers shall be capable of 32-character point names at the building level network.

All field panel priority levels shall be available via the existing graphical workstation.

2.2 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)(MLN) Ethernet network based on TCP/IP protocol, high performance peer-to-peer controller(MBC) (Building Level Network(s))(BLN) and DDC Application Specific Controller (Floor Level Network(s))(FLN) 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 gateways or protocol converters.

Management Level Network(MLN)

1. **One MLN connection to Campus TCP/IP backbone shall be required as minimum for this project. Connection shall be via Siemens APOGEE Ethernet Microserver(AEM). Coordinate AEM and connection with FSU Central Utilities as part of submittals.**

2. BAS workstation PCs shall simultaneously direct connect to the Ethernet and Building Level Network without the use of an interposing device. Operator Workstation shall be capable of simultaneous direct connection and communication with, OPC, and Apogee networks without the use of interposing devices.

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

4. When appropriate, any controller residing on the peer to peer building level networks shall connect to Ethernet network without the use of a PC or a gateway with a hard drive.

5. Any PC on the Ethernet Management Level Network shall have transparent communication with controllers on the building level networks connected via Ethernet, as well as, directly connected building level networks. Any PC shall be able to interrogate any controller on the building level network.

6. Any break in Ethernet communication from the PC to the controllers on the building level networks shall result in an alarm notification at the PC.

7. The Management Level Network shall reside on industry standard Ethernet utilizing standard TCP/IP, IEEE 802.3

8. Access to the system database shall be available from any client workstation on the Management Level Network.

Peer-to-Peer Building Level Network(BLN):

1. All operator devices either network resident or connected via dial-up modems shall have the ability to access all point status and application report data or

execute control functions for any and all other devices via the peer-to-peer network. No hardware or software limits shall be imposed on the number of devices with global access to the network data at any time.

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

3. Each PC workstation shall support a minimum of 4 peer to peer networks hardwired or dial up.

4. The system shall support integration of third party systems (fire alarm, security, lighting, PCL, chiller, boiler) via panel mounted open protocol processor. This processor shall exchange data between the two systems for interprocess control. All exchange points shall have full system functionality as specified herein for hardwired points.

5. Field panels must be capable of integration with open standards including Modbus and Lonworks as well as with third party devices via existing vendor protocols.

6. Building Level Network panels shall be capable of TCP/IP communications connection to management level network(MLN) workstation/host.

7. Telecommunication Capability:

    a. Auto-dial/auto-answer communications capability shall be provided to allow DDC Controllers to communicate with remote operator stations and/or remote terminals via telephone lines, as indicated in the sequence of operations.

    b. Auto-dial DDC Controllers shall automatically place calls to workstations to report alarms or other significant events. The auto-dial program shall include provisions for handling busy signals, "no answers" and incomplete data transfers.

    c. Operators at dial-up workstations shall be able to perform all control functions, all report functions and all database generation and modification functions as described for workstations connected via the network. Routines to automatically answer calls from remote DDC or HVAC Mechanical Equipment Controllers shall be inherent in the Controller. The use of additional firmware or software is not acceptable. The fact that communications are taking place with remote DDC or HVAC & Mechanical Equipment Controllers over telephone lines shall be completely transparent to an operator.

    Multiple modems shall be supported by DDC or HVAC & Mechanical Equipment Controllers on the Peer-to-Peer Network to ensure continuous communication to workstation.

2.3 DDC CONTROLLER FLOOR LEVEL NETWORK(FLN):

A. This level communication shall support a family of application specific controllers and shall communicate with the peer-to-peer network through DDC Controllers for transmission of global data.

2.4 DDC & HVAC MECHANICAL EQUIPMENT CONTROLLERS

The DDC & HVAC Mechanical Equipment Controllers shall reside on the Building Level Network (BLN).

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

DDC & HVAC Mechanical Equipment Controllers which do not meet the functions specified in Section 2.4.1 and Section 2.5 for DDC Controllers or Section 2.4.2 and Section 2.5 for HVAC Mechanical Equipment Controllers are not acceptable.

DDC Controllers (MBC, FLNC) or HVAC Mechanical Equipment Controllers (MEC) shall support FLN networks as described above.

2.4.1 DDC CONTROLLER(MBC)

A. DDC Controllers shall be a 16-bit stand-alone, multi-tasking, multi-user, real-time digital control processors consisting of modular hardware with plug-in enclosed processors, communication controllers, power supplies and input/output point modules. Controller size shall be sufficient to fully meet the requirements of this specification and the attached point I/O schedule. Each controller shall support a minimum of three (3) Floor Level Application Specific Controller Device Networks.

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. Dial-up communications
9. Manual override monitoring

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

D. Provide all processors, power supplies and communication controllers so that the implementation of a point only requires the addition of the appropriate point input/output termination module and wiring.

E. DDC Controllers shall provide a minimum two RS-232C serial data communication ports 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.

F. 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.

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

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.

Manual override points shall be provided for all AHU, CHW, and HW systems. Terminal units, Fan Coil units need not have manual overrides.

G. 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. Graduated intensity LEDs or analog indication of value shall also be provided for each analog output. Status indication shall be visible without opening the panel door.

H. 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.

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:

RF-Conducted Immunity (RFCI) per ENV 50141 (IEC 1000-4-6) at 3 V
Electro Static Discharge (ESD) Immunity per EN 61000-4-2 (IEC 1000-4-2) at 8 kV air discharge, 4 kV contact
Electrical Fast Transient (EFT) per EN 61000-4-4 (IEC 1000-4-4) at 500 V signal, 1 kV power
Output Circuit Transients per UL 864 (2,400V, 10A, 1.2 Joule max)
Isolation shall be provided at all peer-to-peer panel's AC input terminals to suppress induced voltage transients consistent with:
IEEE Standard 587-1980
UL 864 Supply Line Transients
Voltage Sags, Surge, and Dropout per EN 61000-4-11 (EN 1000-4-11)

J. 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 60 days.

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 RS-232C port, via telephone line dial-in or from a network workstation PC.

K. Provide a separate DDC Controller for each AHU or other HVAC system as indicated in Section 3.02. Where practical more than one AHU may be placed into a single DDC controller provided all points for AHU(s) reside in single controller and minimum qty of spare I/O points are maintained.

2.4.2 HVAC MECHANICAL EQUIPMENT CONTROLLERS(MEC)

A. HVAC Mechanical Equipment Controllers shall be a 12-bit stand-alone, multi-tasking, multi-user, real-time digital control processors consisting of modular hardware with plug-in enclosed processors.

B. Each HVAC Mechanical 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. Dial-up communications

A. Each HVAC Mechanical Equipment Controller shall support firmware upgrades without the need to replace hardware.

B. HVAC Mechanical Equipment Controllers shall provide a RS-232C serial data communication port for operation of operator I/O devices such as industry standard printers, operator terminals, modems and portable laptop operator's terminals.

C. 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.

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

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.

Manual override points shall be provided for all AHU, CHW, and HW systems. Terminal units, Fan Coil units need not have manual overrides.

E. HVAC Mechanical Equipment 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.

F. 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.

G. 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:

RF-Conducted Immunity (RFCI) per ENV 50141 (IEC 1000-4-6) at 3 V
Electro Static Discharge (ESD) Immunity per EN 61000-4-2 (IEC 1000-4-2) at 8 kV air discharge, 4 kV contact
Electrical Fast Transient (EFT) per EN 61000-4-4 (IEC 1000-4-4) at 500 V signal, 1 kV power
Output Circuit Transients per UL 864 (2,400V, 10A, 1.2 Joule max)

Isolation shall be provided at all peer-to-peer panel's AC input terminals to suppress induced voltage transients consistent with:

IEEE Standard 587-1980
UL 864 Supply Line Transients
Voltage Sags, Surge, and Dropout per EN 61000-4-11 (EN 1000-4-11)

H. In the event of the loss of normal power, there shall be an orderly shutdown of all HVAC Mechanical Equipment 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 HVAC Mechanical Equipment Controller shall automatically resume full operation without manual intervention.

2. Should HVAC Mechanical Equipment Controller memory be lost for any reason, the user shall have the capability of reloading the HVAC Mechanical Equipment Controller via the local RS-232C port, via telephone line dial-in or from a network workstation PC.

2.5 DDC & HVAC MECHANICAL EQUIPMENT CONTROLLER RESIDENT SOFTWARE FEATURES

A. General:

1. The software programs specified in this Section shall be provided as an integral part of DDC and HVAC Mechanical Equipment Controllers and shall not be dependent upon any higher level computer for execution.

2. All points shall be identified by up to 30 character point name and 16 character point descriptor. The same names shall be used at the PC workstation.

3. All digital points shall have user defined two-state status indication (descriptors with minimum of 8 characters allowed per state (i.e. summer/winter)).

B. Control Software Description:

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

a. Two-position control

b. Proportional control

c. Proportional plus integral control

d. Proportional, integral, plus derivative control

e. Automatic tuning of control loops

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. 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.

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

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

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

b) 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.

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

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.

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.

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. Enthalpy switchover (economizer) .The Energy Management Control Software (EMCS) will 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 EMCS 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. Temperature-compensated duty cycling.

   a) The DCCP (Duty Cycle Control Program) shall periodically stop and start loads according to various patterns.

   b) The loads shall be cycled such that there is a net reduction in both the electrical demands and the energy consumed.

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

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

7. The Peak Demand Limiting (PDL) program shall limit the consumption of electricity to prevent electrical peak demand charges.

   a) PDL shall continuously track the amount of electricity being consumed, by monitoring one or more electrical kilowatt-hour/demand meters. These meters may measure the electrical consumption (kWh), electrical demand (kW), or both.

   b) PDL shall sample the meter data to continuously forecast the demand likely to be used during successive time intervals.

   c) If the PDL forecasted demand indicates that electricity usage is likely to exceed a user preset maximum allowable level, then PDL shall automatically shed electrical loads.

   d) Once the demand peak has passed, loads that have been shed shall be restored and returned to normal 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 character, English language point names, structured for searching and logs.

2. Processes shall be able to generate operator messages and advisories to operator I/O devices. A process shall be able to directly send a message to a specified device or cause the execution of a dial-up connection to a remote device such as a printer or pager.

3. DDC and HVAC Mechanical Equipment Controller shall provide a HELP function key, providing enhanced context sensitive on-line help with task orientated information from the user manual.

4. 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 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. Operator-initiated automatic and manual loop tuning algorithms shall be provided for operator-selected PID control loops as identified in the point I/O summary.

a. Loop tuning shall be capable of being initiated either locally at the DDC and HVAC Mechanical Equipment Controller, from a network workstation or remotely using dial-in modems. For all loop tuning functions, access shall be limited to authorized personnel through password protection.

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 without dependence upon a central or intermediate processing device. DDC and HVAC Mechanical Equipment Controllers shall send alarm reports to multiple workstation without dependence upon a central or intermediate processing device. 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.

2.6 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, real-time digital control processor. Provide the following types of ASCs as a minimum:

1. Terminal Equipment Controllers
2. Digital Energy Monitors
3. Third Party FLN (P-1) Siemens approved devices(variable frequency drives, electric switch gear monitors, etc.)

Each ASC shall be capable of control of the terminal device independent of the manufacturer of the terminal device. Third party devices shall be fully capable of normal non-communicating operations and operator interface as provided by device manufacturer.

C. Terminal Equipment Controllers(TEC):

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

a. Variable Air Volume (VAV) boxes

b. Constant Air Volume (CAV) boxes

c. Dual Duct Terminal Boxes

d. Unit Conditioners

e. Heat Pumps

f. Unit Ventilators

g. Room Pressurization

h. Lab Room Controller

I. Fume Hood Monitor / Controller

2. 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, 0-10v ,allowing for interface to a variety of modulating actuators.

3. 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

Digital Energy Monitors(DEM):

Provide three phase digital watt-meters with pre-wired CTs. All watt-meter electronics shall be housed within the CTs. CTs shall include sizes capable of mounting directly on a power bus. Diagnostics visible to the installing electrician (without a operator tool) shall indicate: proper operation, mis-wiring or low power-factor, device malfunction, and over-load condition. The meters shall include the following:

a. The device shall be UL Listed, and shall comply with ANSI C12.1 accuracy specification. The minimum CT/meter combined accuracy shall be no greater than 1% of reading over the range of 5% to 100% of rated load. The meter shall not require calibration

The wattmeter shall directly connect to power from 208 through 480 with no potential transformer. In-line fuses for each voltage tap phase shall be included.

b. The wattmeter CTs shall be split-core and at minimum be sized to accommodate loads ranging from 100 to 2400 Amps. The CTs shall be volt-signal type, and shall not require shorting blocks.

c. The wattmeter shall reside directly on the Floor Level Network along with other FLN devices. Data transferred shall include
kW & kWH
Consumption
Demand
Power Factor
Current
Voltage
Apparent Power
Reactive Power

2.7 PORTABLE OPERATOR'S TERMINAL (POT)

A. Where specified as required provide industry standard, commercially available portable operator terminals with a LCD display and a full-featured keyboard. The POT shall be handheld and plug directly into 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 connected at any DDC Controller:

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

2. Backup and/or restore DDC Controller data bases 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 connected to any application specific controller:

1. Provide connection capability at either the Floor Level Network Controller or a related room sensor to access controller information.

2. Provide status, setup and control reports.

3. Modify, select and store controller data base.

4. 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.

2.8 LOCAL USER DISPLAY

Where specified in the sequence of operation or points list, the controllers on the peer to peer building level network shall have a display and keypad for local interface. A keypad shall be provided for interrogating and commanding points in the controller.

The display shall use the same security password and access rights for points in the display as is used in the associated controller.

The LCD display shall be a minimum of a 2 line 40 character display.
The LCD display shall include the full point name, value (numeric, digital or state text),

point priority and alarm status on one screen.

The LCD shall dynamically update the value, priority, and alarm status for the point being displayed.

The display shall be mounted either on the door of the enclosure or remote from the controller

2.9 PERSONAL COMPUTER OPERATOR WORKSTATION HARDWARE

A. Where specified personal computer operator workstations shall be provided for command entry, information management, network alarm management and database management functions. All real-time control functions shall be resident in the DDC Controllers to facilitate greater fault tolerance and reliability.

1. Workstation(s) locations (NONE REQUIRED)

2. Workstation shall consist of an SVGA 19" color monitor, personal computer with minimum 512 MB RAM, 40.0 GB hard drive and controller, 3-l/2" diskette drive, 20X CDRW drive, mouse and 101-key enhanced keyboard. Personal computer shall be an IBM Compatible PC and shall include a minimum 1.5GHZ Pentium IV processor.

3. The minimum display resolution of no less than 1024 X 768 pixels. Separate controls shall be provided for color, contrasts and brightness. The screen shall be non-reflective.

B. Provide an Epson FX-870 or equivalent printer at each workstation location or on the network (Ethernet) for recording alarms, operator transactions and systems reports, meeting the following minimum requirements:

2.10 WORKSTATION OPERATOR INTERFACE

A. Basic Interface Description(APOGEE Workstation)

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 up to 4 Building Level Networks and share data between any of the 4 networks. The software shall provide, as a minimum, the following functionality:

a. Real-time graphical viewing and control of environment
b. Scheduling and override of building operations
c. Collection and analysis of historical data
d. Point database editing, storage and downloading of controller databases.
e. Alarm reporting, routing, messaging, and acknowledgment
f. Display dynamic data trend plot.
   - Must be able to run multiple plots simultaneously
   - Each plot must be capable of supporting 10 pts/plot minimum
   - Must be able to command points directly off dynamic trend plot application.
g. Definition and construction of dynamic color graphic displays.
h. Program editing
i. Transfer trend data to 3rd party software
j. Scheduling reports
k. Operator Activity Log
l. Open communications via OPC Server

2. Provide a 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 a Windows NT 32 bit operating. 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.

   a. 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).

      1. Dynamic color graphics and graphic control

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

      3. Year in advance event and report scheduling

      4. Dynamic trend data definition and presentation

      5. Graphic definition and construction

      6. Program and point database editing on-line.

   b. If the software is unable to display several different types of displays at the same time, the BAS contractor shall provide at least two operator workstations.

   c. Report and alarm printing shall be accomplished via Windows Print Manager, allowing use of network printers.

4. 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).

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

   a. A general listing of all or selected points in the network
   b. List of all points currently in alarm

c. List of all points currently in override status
d. List of all disabled points
e. List of all points currently locked out
f. List of user accounts and access levels
g. List all weekly schedules
h. List of holiday programming
i. List of limits and deadbands
j. Custom reports from 3rd party software
k. System diagnostic reports including, list of DDC panels on line and communicating, status of all DDC terminal unit device points
l. List of programs

6. Scheduling and override

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:

a. Weekly schedules
b. Zone schedules, minimum of 200 unique zones
c. Scheduling for up to 365 days in advance
d. Schedule reports to print at PC.

7. Collection and Analysis of Historical Data

a. 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.

b. 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. Provide additional functionality that allows the user to view real-time trend data on trend graph displays. A minimum of ten points may be graphed, regardless of whether they have been predefined for trending. The dynamic graphs shall continuously update point values. At any time the user may redefine sampling

times or range scales for any point. In addition, the user may pause the graph and take "snapshots" of screens to be stored on the workstation disk for future recall and analysis. Exact point values may be viewed and the graphs may be printed. A minimum of 8 true graphs shall run simultaneously. Operator shall be able to command points directly on the trend plot by double clicking on the point.

B. Dynamic Color Graphic Displays

1. Create standard **FSU Central Utilities** required color graphic 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. **Coordinate with FSU CUP prior to generation of displays for current standards.**

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.

   b. 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.
   c. Provide the user the ability to display blocks of point data by defined point groups; alarm conditions shall be displayed by flashing point blocks.
   b. Equipment state can be changed by clicking on the point block or graphic symbol and selecting the new state (on/off) or setpoint.
   c. State text for digital points can be defined up to eight characters.

4. Colors shall be used to indicate status and change as the status of the equipment changes. The state colors shall be user definable.

5. 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.

6. Off the shelf graphic software, Microgafx Designer or Coral Draw software shall be provided to allow the user to add, modify or delete system graphic displays.

4. A clipart library of HVAC and automation symbols shall be provided including fans, valves, motors, chillers, AHU systems, standard ductwork diagrams and laboratory symbols. The user shall have the ability to add custom symbols to the clipart library.

8. A dynamic display of the site specific architecture showing status of controllers, PC workstations and networks shall be provided.

C. System Configuration & 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.

D. 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 icons, to distinguish between routine, maintenance type alarms and critical alarms. These alarm icons 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 icon.

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.

E. Workstation Communications

1. Communications for building workstations (if provided) are as specified for MLN connection to FSU Campus backbone and shall be performed via building premise wiring supplied by others.

Web Based Operator Interface(APOGEE Web Based Workstation)

Where specified the BAS shall provide a web based graphical interface (PC with Web Browser) that allows users to access the Siemens APOGEE server systems data via the Internet, extranet, or Intranet. The interface shall use HTML based ASP pages to send and receive data from the BAS to a web browser as described below.

An existing web server computer utilizing Siemens APOGEE GO web enabled software is supported by FSU at the Mendenhall bldg.. The web server shall use Microsoft's IIS server 4.0 with Windows NT4, or IIS 5.0 with Windows 2000, and support browser access via Microsoft Internet Explorer 5.0 (or higher), or Navigator Netscape 6.0 (or higher).

All information exchanged over Internet shall be optionally encrypted and secure via SSL (provided by Owner).

Access to the web interface may be password protected. A users rights and privileges to points and graphics will be the same as those assigned at the BAS workstation. An option will exist to only allow users "read" access via the web browser, while maintaining "command" privileges via the BAS workstation.

Commissioning of the Web interface shall not require modification or creation of HTML or ASP pages. All graphics available at the BAS graphical workstation shall be available to users via a web browser.

The web-based interface shall provide the following functionality to users, based on their access and privilege rights:

Logon Screen – allows the user to enter their user name, password and Domain name for logging into the web server.

Alarm Display – a display of current BAS alarms to which the user has access will be displayed. Users will be able to acknowledge and erase active alarms, and link to additional alarm information including alarm messages, and informational and memo text. Any alarm acknowledgements initiated through the web interface will be written to the BAS central workstation activity log.

Graphic Display – Display of system graphics available in the BAS workstation will be available for viewing over the web browser. Software that requires creation of "web" graphics in order to display them via the browser interface will not be acceptable. A graphic selector list will allow users to select any graphics to which they have access. Graphic displays will automatically refresh with the latest change of values. Users will have the ability to command and override points from the graphic display as determined by their user accounts rights.

Point details – users will have access to point detail information including operational status, operational priority, physical address, and alarm limits, for point objects to which they have access rights.

Point Commanding – users will be able to override and command points they have access to via the web browser interface. Any commands or overrides initiated via the web browser interface will be written to the BAS central workstation activity log.

Internet connections, ISP services, as well as necessary firewalls or proxy servers shall be provided by the Owner as required to support the web access feature.

2.10a UNINTERRUPTIBLE POWER SUPPLY SYSTEM

A. Provide an advanced, modular power management UPS power management package for the computer equipment and all DDC Controllers(MBC, MEC). Provide unit sized for the equipment supplied at a minimum 420 VA, with 15 minute emergency runtime.

2.10b POWER SUPPLIES AND LINE FILTERING

A. Control transformers shall be UL Listed. Furnish Class 2 current-limiting type, or furnish over-current protection in both primary and secondary circuits for Class 2 service per NEC requirements. Limit connected loads to 80% of rated capacity.

DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100 microsecond response time for 50% load changes. Unit shall have built-in over-voltage and over-current protection, and shall be able to withstand a 150% current overload for at least 3 seconds without trip-out or failure.

Unit shall operate between 0°C and 50°C [32°F and 120°F]. EM/RF shall meet FCC Class B and VDE 0871 for Class B, and MIL-STD 810C for shock and vibration.

Line voltage units shall be UL Recognized and CSE Approved.

B. Power line filtering.

Provide transient voltage and surge suppression for all workstations and controllers either internally or as an external component. Surge protection shall have the following at a minimum:

i. Dielectric strength of 1,000 volts minimum
ii. Response time of 10 nanoseconds or less
iii. Transverse mode noise attenuation of 65 dB or greater
iv. Common mode noise attenuation of 150 dB or better at 40 Hz to 100 Hz.

2.11 FIELD DEVICES

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

A. Room Temperature Sensors

1. TEC Applications: Provide a loop powered sensor utilizing a 10k ohm thermistor element. Sensor shall include a RJ-11 port to provide means of communication with external portable operators terminal. Digital room sensors shall have LCD display, day / night override button, and setpoint slide adjustment override options. The setpoint slide adjustment can be software limited by the automation system to limit the amount of room adjustment. Color shall be white.

2. MBC, MEC Applications: Provide a loop powered sensor utilizing a 1k ohm Platinum RTD element. Digital room sensors shall have LCD display, day / night override button, and setpoint slide adjustment override options. The setpoint slide adjustment can be software limited by the automation system to limit the amount of room adjustment. Color shall be white.

Temperature monitoring range	+20/120°F -13° to 49°C)
Output signal	Changing resistance
Accuracy at Calibration point	±0.5°F (+/- 0.3°C)
Set Point and Display Range	55° to 95° F (13° to 35°C)

B. Temperature Sensors (Duct, Liquid immersion, Outside Air)

Provide a loop powered sensor utilizing a 100 ohm Platinum RTD element. Provide separable wells of 300 stainless steel with thermal compound for immersion sensors. Sensors to have connection for conduit. Outside air sensors to have shield to minimize solar effects and shall be mounted to minimize building mass interference.

Non Chilled Water	
Liquid immersion temperature:	# 536-767
Temperature monitoring range	+30/250°F (-1°/121°C)
Output signal	4-20 ma loop powered
Accuracy at Calibration point	±1°F (+/-0.5°C)

Chilled Water	
Liquid immersion temperature:	# 536-744
Temperature monitoring range	+20/70°F (-7°/21°C)
Output signal	4-20 ma loop powered
Accuracy at Calibration point	±0.6°F (+/-0.3°C)

Duct, Outside Air temperature:	# varies
Temperature monitoring range	+20/120°F (-7°/49°C)
Output signal	4-20 ma loop powered
Accuracy at Calibration point	±0.5°F (+/-0.3°C)

C. Humidity Sensors(Room, Duct)

1. Provide a loop powered 4-20 ma sensor utilizing a bulk polymer element Duct Sensors to have connection for conduit. Room sensors color shall be white.

Humidity Sensors:	
Range	0 to 100% RH
Sensing Element	Bulk Polymer
Output Signal	4 – 20 mA DC
Accuracy	At 77°F(25ºC) ± 2% RH

D. Liquid Differential Pressure Transmitter(Chilled & Hot Water):

1. Provide a loop powered 4-20 ma sensor as manufactured by Setra model 230 or pre-approved equal. Differential Unit shall be provided with a three valve manifold

Ranges	0-5/30 inches H20 0-25/150 inches H20 0-125/750 inches H20
Output	4 – 20 mA DC
Calibration Adjustments	Zero and span
Accuracy	+-0.2% of span
Linearity	+-0.1% of span
Hysteresis	+-0.05% of span

E. Differential Pressure Switch:

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

Unit for air flow 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)

F. Static & Velocity Air Pressure Transmitter:

1. Provide a loop powered 4-20 ma sensor as manufactured by Setra model C264 or pre-approved equal.

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)
Output Signal	4 – 20 mA VDC
Combined static error	0.5% full range
Operating Temperature	-40º to 175º F (-40C to 79.5ºC)

G. Flow Meters(Chilled & Hot Water)

Provide a loop powered 4-20 ma insertion type flow meter as manufactured by Data Industrial hot tap model SDI for pipe diameters 1-1/2” to 36” for chilled water applications. Data Industrial inline model Series 250B tee style for pipe sizes ½” to 1-1/4” for chilled water. Hot water applications shall utilize the Series 220 high temperature model. Pre-approved equals may be considered.

Sensing Method	Impedance Sensing
Accuracy	+ 1% of Actual Reading
Maximum Operating Pressure	400 PSI
Output Signal	4 – 20 mA

Bi-directional where required.

H. Flow Meters(Steam)

A steam flow meter must be installed on the high side steam pressure entering the building. Flow meter shall be Yokogawa or pre-approved equal. The meter should be flanged or wafer style with a visual local readout. The meter must be sized to cover the range of steam flow with greater emphasis on low flow. Oversized meters will not be accepted. At a minimum the following meter specifications must be met:

·Accuracy + - 0.8% of rate for gases <115 ft/sec
·5 point linearization function
·mismatched pipe correction
·Reynolds number linearization
·Automatic gas expansion factor correction
·Temperature compensation
·Turn down of at least 20:1

Display can be rotated in 90 degree increments to match mounting orientation of the meter.
·Shedder bar replacement without removing the meter from the line.

Pressure to Current Transducer(Water, Steam, Refrigeration)

1. Provide a loop powered 4-20 ma sensor as manufactured by Ashcroft Duratran model 2279 or pre-approved equal. All pressure sensors to be fitted with snubber to prevent damage from surges in line pressure. Refrigerant pressure sensors to have range suitable for refrigerant measured.

Range	30” vac to 15 psig(refrig) 0 to 100 psig (Hi press Steam)
Output signal	4 – 20 ma
Accuracy	$\pm$ 1% of full scale

Steam pressure transmitter on the high & low side of pressure regulators. This transmitter shall be as manufactured by Yokogawa Dpharp model or pre-approved equal with a calibrated range of 0-150 psig. Steam applications shall be provided with steam pigtail siphon.

Conductivity Sensors(Steam condensate & hot water)

On the return condensate and leaving heat exchanger hot water lines there shall be a two wire loop powered conductivity transmitter installed. This transmitter should be Yokogawa model SC200 or pre-approved equal. The probe assembly shall be a matched 4-Electrode system. Where pipe sizes are less than 6’ the mechanical contractor shall provide a small section of pipe suitable for installation of probe.

CO2 Sensors

Siemens QPA63 series CO2/VOC sensors shall be utilzed for sensing indoor air quality in rooms or air ducts. The microprocessor-based units consist of a photo-acoustic CO2 sensor and a VOC (Volatile Organic Compound) sensor with a heated stannic dioxide semiconductor. The photo acoustic CO 2 sensor experiences shall have less than 1% drift per year for the

first two years of operation and negligible drift there after, no calibration of the CO2 sensor is necessary.

Operating characteristics

CO2 measuring range	0 — 2000 ppm
Tolerance	±100 ppm
Output	0 – 10 Vdc, linear
Calibration	None required
VOC measuring range	0 — 10 VVOC
Permissible air velocity in the duct	<26.2 ft/s

Water Valves

1. Body and trim style and materials shall be per manufacturer's recommendations for design conditions and service shown, with equal percentage ports for modulating service. Valves shall have 5 year product warranty. Valves for building chilled water and building hot water main equipment shall include feed back.

2. Sizing Criteria:

Two-position service: Line size.
Two-way modulating service: Pressure drop shall be equal to twice the pressure drop through heat exchanger (load), 50% of the pressure difference between supply and return mains, or 5 psi, whichever is greater.
Three-way modulating service: Pressure drop equal to twice the pressure drop through the coil exchanger (load), 35 kPa [5 psi] maximum.
Valves 1/2" through 2" shall be bronze body or cast brass ANSI Class 250, spring-loaded, Teflon packing, quick opening for two-position service. Two-way valves to have replaceable composition disc, or stainless steel ball.
2-1/2" valves and larger shall be cast iron ANSI Class 125 with guided plug and Teflon packing or butterfly valves with 100 psi shutoff minimum and stainless steel trim suitable for service.

Steam Valves:

Body and trim materials shall be per manufacturer's recommendations for design conditions and service. Linear ports for modulating service. Heat exchanger and PRV valves shall have a 5 year product warranty and shall include feedback. Actuator stroke shall be no higher than 60 seconds and shall fail closed via spring return.

Sizing Criteria:

Two-position service: Pressure drop 10% to 20% of inlet psig.
Modulating service: 100 kPa [15 psig] or less: pressure drop 80% of inlet psig.
Modulating service: 101 to 350 kPa [16 to 50 psig]: pressure drop 50% of inlet psig.
Modulating service: Over 350 kPa [50 psig]: pressure drop as scheduled on plans.

Damper Actuators

1. Electric control shall be Siemens Building Technologies OpenAir™ 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.

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

3. Actuators shall be designed for mounting directly to the damper shaft without the need for connecting linkages.

4. 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.

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

6. All actuators shall be designed and manufactured using ISO900registered procedures, and shall be Listed under Standards UL873 and CSA22.2 No. 24-93 l.

2.12 MISCELLANEOUS DEVICES

A. Thermostats
   1. Room thermostats shall be of the gradual acting type with adjustable sensitivity.
   2. They shall have a bi-metal sensing element capable of responding to a temperature change of one-tenth of one degree. (Provide all thermostats with limit stops to limit adjustments as required.)
   3. Thermostats shall be arranged for either horizontal or vertical mounting.
   4. In the vertical position thermostat shall fit on a mullion of movable partitions without overlap.
   5. Mount the thermostat covers with tamper-proof socket head screws.

B. Freezestats:

   1. Install freezestats as indicated on the plans and provide protection for every square foot of coil surface area with one linear foot of element per square foot of coil.

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

C. Firestats:

Provide manual reset, fixed temperature line voltage type with a bi-metal actuated switch.

Switch shall have adequate rating for required load.

D. Electronic Airflow Measurement Stations and Transmitters (At Duct Locations).

1. Stations – each insertion station shall contain an array of velocity sensing elements and straightening vanes. The velocity sensing elements shall be of the velocity presure type. The sensing elements shall be distributed across the duct cross section in a quality to provide accurate readings. The resistance to airflow through the airflow measurement station shall not exceed 0.08 inches water gage at an airflow of 2,000 fpm. 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. Each transmitter shall produce a linear 4 to 40 mA DC, output corresponding to the required velocity pressure measurement.
2. Acceptable manufacturers are Brandt series DSK9000 or pre-approved equal.

E. 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.

2.14 LABORATORY SUPPLY, EXHAUST and FUME HOOD VENTURI AIRVALVES:

Laboratory airvalves shall provide a minimum turndown ratio of 5 to 1 for fume hood exhaust applications and adequate turndown for room supply and general exhaust applications to assure that room pressurization is maintained. All airvalves 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 published airflow range of each device.

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.

All supply, exhaust and fume hood venturi or blade style airvalves shall include factory-installed airflow sensors. The airvalves should provide stable and precise airflow control of room supply, room general exhaust and fume hood exhaust. The valves shall be constructed of aluminum including the casing and cone. The control shaft shall be 316 stainless steel. For highly corrosive environments, Teflon® coated steel and Heresite® coated aluminum shall be available. Flange or slip fitting end connections should also be available to match ductwork construction. Single body air valves should be available in sizes from 5” to 12”

diameter, with airflow ranges from 30 CFM to 1,750 CFM. Dual 10", Dual 12", triple 12" and quad 12" sizes should be

Airflow measurement and fume hood exhaust application shall be accomplished by a unique orifice plate or array sensing technology that minimizes pressure loss and duct obstruction. Airflow measurement accuracy shall be within +/-5% of reading down to duct velocities of 450fpm.

Fast-acting flow control applications use shall utilize full PID airflow control as "fine tuning" of the venturi airvalve's calibrated relationship of control position to airflow rate, allowing control below 450 fpm duct velocities, down to the minimum specified flows for each size. High speed, precise response is delivered using the Siemens Lab Electronic Actuator. Minimum to maximum valve airflow (or visa versa) shall be attained in less than 1 second.

Basic electronic actuation can also be used for constant volume and constant volume, 2-position airflow control applications, with the controller utilizing the integral airflow measuring technology and the venturi airvalve's inherent pressure-independence.

The venturi airvalve package shall have the following features (as a minimum):

- Fast-acting or basic electronic actuation
- Multiple sizes and end configurations to match laboratory supply and exhaust duct requirements
- Coating and material options for highly corrosive environments
- Airvalve is Factory Calibrated and Field commissionable
- Controllers utilize airflow measurement for performance diagnostics
- Controllers utilize automatic airflow sensor calibration
- All venturi airvalves shall have a three range pressure drop options, low (0.3"-3.0"), medium (0.6"-3.0") and high (1.0"-6.0").
- A loss, increase and/or decrease of airflow shall be transmitted to the fume hood or room controller as appropriate.
- Discharge and Radiated sound power level data for all venturi airvalves shall be available and provided at the owner's or engineer's request. The data shall be in accordance with the test procedure in ARI 880-89 Standard for Venturi airvalves and all data shall be obtained in a qualified, accredited and ARI approved testing laboratory.
- Venturi airvalves that require factory calibration shall be calibrated to the job specific airflow's indicated on the drawings. Factory calibration shall be conducted on certified NIST traceable air stations and shall be conducted for eight airflows including a test of pressure independence at three static pressures. NIST instrument certificates shall be provided as evidence of compliance. Each airvalve shall be individually marked with its specific factory calibration data. As a minimum, include tag number, serial number, model number, eight point characterization information, and quality control inspection numbers. All information shall be available for inclusion on as-built drawings.
- Room and fume hood airflow accuracy and performance shall be guaranteed as specified irrespective of field conditions.
- In order to guarantee safety and compliance, LACS systems that do not measure actual airflow must provide independent airflow measuring stations. Independent airflow measuring stations shall be provided at each supply air valve, general exhaust air valve and fume hood exhaust air valve for each laboratory or pressurized space. The signals from these measurement stations shall be directly linked to the central BAS. Airflow

measurement stations shall consist of an averaging airflow sensor, which shall provide an average duct velocity pressure to an airflow transmitter. Airflow transmitters shall provide an output of 4-20 mA proportional to velocity pressure. Airflow transmitters shall have an accuracy of at least +/-0.5% of the transmitter range.

2.14A LABORATORY SUPPLY AND EXHAUST BLADE STYLE AIR TERMINALS

Electronically actuated terminal units shall be pressure independent with airflow accuracy of +/- 5% over the air flow range of the terminal. Airflow measurement accuracy MUST be AMCA certified. Also, it shall be certified by a qualified, accredited and independent testing source. Turn down ratio to be 5 to 1 on fume hood exhaust terminals and at least 8 to 1 on supply and general exhaust terminals. The response time to vary the terminal units' airflow from its' minimum to maximum value or visa versa shall be less than 3 seconds.

Exhaust airflow measurement shall be provided by techniques that minimally obstruct the exhaust duct.

All supply air terminals shall be constructed of 16-gauge aluminum or 20 gauge galvanized steel. Bearings shall be composite Teflon or Teflon infused aluminum.

Supply air terminals to have integral sound attenuation and reheat coils.

Supply terminals shall be capable of 100% shut-off. Supply terminal air leakage shall not exceed 5% of design airflow at 4 inches w.g. positive static pressure.

All exhaust terminals shall be constructed of 316 stainless steel or coated with corrosion resistant Teflon. Damper shaft shall be solid stainless steel with Teflon bearings. Special corrosion resistant requirements, if any, for fume hood exhaust terminals shall be as indicated on the drawings.

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

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

Published sound level data for all terminals shall be available and provided at the owner's or engineer's request. The data shall be in accordance with the test procedure in ARI 880-89 Standard for Air Terminals and substantiated by a statement of certification from a qualified, accredited and independent testing source other than the manufacturer.

Terminals that are not calibrated in the field shall be factory calibrated to job specific airflows as indicated on the drawings. Calibration shall be conducted on certified NIST traceable air stations (include NIST certificates with each air terminal). Calibration shall be conducted for eight airflows including a test of pressure independence at three static pressures.

Accuracy and performance shall be guaranteed as specified irrespective of field conditions.

Each device shall be individually marked with specific factory calibration data. As a minimum, include tag number, serial number, model number, eight point

characterization information, and quality control inspection numbers. All information shall be available for inclusion on as-built drawings.

In order to guarantee safety and compliance, LACS systems that do not measure actual airflow must provide independent airflow monitoring stations. An independent airflow station will be provided at each supply valve, general exhaust valve and fume hood exhaust valve for each laboratory or pressurized space. The signals from these stations will be directly linked to the central BAS. The airflow monitoring station shall consist of an averaging airflow sensor, which shall provide an average duct velocity pressure to the airflow transmitter. Airflow transmitter shall have an output of 4-20 ma proportional to velocity pressure. The airflow transmitter will have an accuracy of at least +/-.5% of the transmitter range.

2.15 LABORATORY ROOM CONTROLLER

Each supply and associated exhaust terminal shall be controlled to maintain an actual CFM airflow differential between total room exhaust and supply air that is equal to 10% of the maximum laboratory room design airflow or 200 CFM, whichever is greater, to meet space pressurization requirements. For negatively pressurized rooms, supply airflow shall be controlled to equal the total room exhaust airflow less the required airflow differential. For positively pressurized rooms, total exhaust airflow shall track supply airflow less the required airflow differential Room airflow tracking shall be accomplished via actual measurement of terminal unit airflow. Controllers that track within a range of airflow's versus actual airflow setpoints shall not be acceptable.

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.

Controllers using a differential pressure switch to monitor differential pressure across control devices such as an air valve shall include provisions for manual and automatic zeroing in order to maintain stable control and ensure against drift over time.

Controller shall include all inputs and outputs necessary to perform all ~~the~~ specified control sequences.

Each controller shall operate stand alone, performing its specified control responsibilities independently.

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.

Should a power failure or operational failure occur within the controller, the terminal unit damper shall automatically be positioned to the fully open or fully closed (failsafe) position as defined by the owner.

2.16 VARIABLE AIR VOLUME FUME HOOD CONTROLLER

Where VAV Hood operation is required 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.

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.

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 1 second after completion of sash movement. Control scenarios that are not based upon sash sensing such as those utilizing side wall airflow sensing must substantiate that fume hood face velocity will be restored within 1 second after completion of sash movement. ASHRAE 110 VAV fume hood response time test data substantiating this performance requirement shall be submitted. All such ASHRAE 110 testing shall be conducted by a qualified, accredited and independent testing source.

Air velocity sensors utilized for side-wall sensing shall be UL 913 listed. Documentation of UL listing shall be submitted with the technical proposal and included with the submittals.

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.

The face velocity setpoint shall be adjustable by authorized owner personnel

Controllers shall include the ability to accept and incorporate into the control sequence a dry contact closure from auxiliary sensors. Example: Occupancy override, Emergency button, etc.

Controllers shall provide a general alarm output for use with auxiliary devices.

Momentary or extended losses of power shall not change or affect any of the control system’s setpoints, calibration settings, or emergency ~~exhaust mode~~ status. After power returns the system shall continue operation exactly as before without need for any manual intervention.

2.16 FUME HOOD OPERATOR DISPLAY

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:

- 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.
- 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.
- A user initiated emergency purge function shall initiates a 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.

2.17 SASH SENSOR

Where VAV Hood Operation is required 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 one half inch.

Sash sensors material shall be corrosion resistant.

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

Operational life of each sash sensor shall be a minimum of 1000,000 full cycles.

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

PART 4 - EXECUTION

4.1 PROJECT MANAGEMENT

Provide a designated project manager who will be responsible for the following:
- Construct and maintain project schedule
- On-site coordination with all applicable trades, subcontractors, and other integration vendors
- Authorized to accept and execute orders or instructions from owner/architect
- Attend project meetings as necessary to avoid conflicts and delays
- Make necessary field decisions relating to this scope of work
- Coordination/Single point of contact

4.2 SEQUENCE OF OPERATION

job specific - per job requirements
Refer to the APPLICATION SPECIFIC REQUIREMENTS FOR FSU BAS SYSTEMS section above and the Director of Utilities for current mechanical control system diagrams, sequences, and point I/O summaries available in electronic format for inclusion.

4.3 POINT SCHEDULE MATRIX - I/0 SCHEDULE

attach I/O schedule
Refer to the APPLICATION SPECIFIC REQUIREMENTS FOR FSU BAS SYSTEMS section above and the Director of Utilities for current mechanical control system diagrams, sequences, and point I/O summaries available in electronic format for inclusion.

**All Point names and panel numbers will be coordinated with FSU prior to submission of technical documentation.

4.4 START-UP AND COMMISSIONING

A. When installation of the system is complete, calibrate equipment and verify transmission media operation before the system is placed on-line. All testing, calibrating, adjusting and final field tests shall be completed by the manufacturer. Verify that all systems are operable from local controls in the specified failure mode upon panel failure or loss of power.

B. Provide any recommendation for system modification in writing to owner. Do not make any system modification, including operating parameters and control settings, without prior approval of owner.

C. After manufacturer has completed system start-up and commissioning. Joint commissioning of integrated system segments shall be completed.

4.5 ELECTRICAL WIRING AND MATERIALS

Install, connect and wire the items included under this Section. This work includes providing required conduit, wire, fittings, and related wiring accessories. All

wiring shall be installed in conduit or plenum rated not installed in conduit as allowed and in accordance with all applicable codes.

Division 16 contractor to provide 120 volt, single phase, 60 hertz emergency power to every B.M.S. DDC Controller panel, HVAC/Mechanical Equipment Controller, PC console, power supply, transformer, enunciator, modems, printers and to other devices as required. It is the intent that the entire building management system except terminal equipment shall be operative under emergency power conditions in the building.

All wiring to be compliant to local building code and the NEC.

Provide electrical wall box and conduit sleeve for all wall mounted devices.

All plenum rated wiring installed shall be supported with J hooks or other approved devices utilizing plenum rated tie-wraps or bare copper wire #16 solid or as approved

4.6 PERFORMANCE

A. Unless stated otherwise, control temperatures within plus or minus 2^{o}F humidity within plus or minus 3% of the set point and static pressure within 10% of set point.

4.7 COMMISSIONING, TESTING AND ACCEPTANCE

Perform commissioning procedures consisting of field I/O calibration and commissioning, system commissioning and integrated system program commissioning. Document all commissioning information on commissioning data sheets which shall be submitted prior to acceptance. Commissioning work which requires shutdown of system or deviation from normal function shall be performed when the operation of the system is not required. The commissioning must be coordinated with the owner and construction manager to ensure systems are available when needed. Notify the operating personal in writing of the testing schedule so that authorized personnel from the owner and construction manager may present throughout the commissioning procedure.

Prior to system program commissioning, verify that each control panel has been installed according to plans, specifications and approved shop drawings. Test, calibrate and bring on line each control sensor and device. Commissioning to include, but not be limited to:

a. Sensor accuracy at 10, 50 and 90% of range.

b. Sensor range.

c. Verify analog limit and binary alarm reporting.

d. Point value reporting.

e. Binary alarm and switch settings.

f. Actuator ranges.

g. Fail safe operation on loss of control signal, electric power, network communications.

After control devices have been commissioned (i.e. calibrated, tested and signed off), each BMS program shall be put on line and commissioned. The contractor shall, in the presence of the owner and construction manager, demonstrate each programmed sequence of operation and compare the results in writing. In addition, each control loop shall be tested to verify proper response and stable control, within specified accuracies. System program test results shall be recorded on commissioning data sheets and submitted for record. Any discrepancies between the specification and the actual performance will be immediately rectified and retested.

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4.8 EXISTING CONTROL DEVICES

A. The bid for the control work shall be based on the premise that existing control devices are operational and are not in need of repair or replacement, unless otherwise noted.

B. This subcontractor shall notify the owner's representative of existing control devices that need to be replaced or repaired that may be noted in the process of installation of the new work.

4.9 TRAINING

The manufacturer shall provide factory trained instructor to give full instruction to designated personnel in the operation of the system installed. Instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach. The manufacturer shall provide all students with a student binder containing product specific training modules for the system installed. All training shall be held during normal working hours of 8:00 am to 4:30 PM weekdays.

4 hours of training for 4 of the owner’s personnel to be delivered before final acceptance.

hours of jobsite installation familiarization for the owners personnel.

4.10 LABORATORY / ANIMAL LAB EXHAUST/SUPPLY HVAC SYSTEMS INSTALLATION

The laboratory ventilation system contractor shall install the sash sensors, control equipment, and operator display panels on fume hoods. This contractor shall install and terminate all low voltage control wiring between each controller and all control and sensing devices, and provide 24 VAC power where required by the controllers and control devices.

The electrical contractor shall provide 120volt emergency power circuit in the laboratory ceiling space for connection to the laboratory control equipment.

Supply venturi air valves with reheat coils, exhaust venturi airvalves and valves shall be installed by the mechanical contractor.